T.O. 37C2-8-19-13

TECHNICAL MANUAL

OVERHAUL INSTRUCTIONS

5000 GALLON LIQUID OXYGEN/NITROGEN STORAGE TANK TYPE TMU-20/E

Part Number	National Stock Number
80-507	3655-01-105-8765YD
SV-50-LN-SK	3655-01-263-7635YD

LOX EQUIPMENT COMPANY

F41608-87-D-0220

Prepared By: SA-ALC Automated Technical Order System (ATOS).

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LIST OF EFFECTIVE PAGES

INSERT LATEST CHANGED PAGES. DESTROY SUPERSEDED PAGES.

NOTE: The portion of the text affected by the changes is indicated by a vertical line in the outer margins of the page. Changes to illustrations are indicated by miniature pointing hands. Changes to wiring diagrams are indicated by shaded areas.

Dates of issue for original and changed pages are:

Original ..... 0 ..... 6 Mar 91 Change ..... 2 ..... 31 Mar 95
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FOREWORD/PREFACE

Purpose. This technical manual will provide the using activity with operation and service instructions for the Liquid Oxygen and Nitrogen Storage and Transfer Tank, Type TMU-20/E.

Scope. This manual will provide the using activity with applicable information required on the handling, storage, and hazards associated with the use of cryogenic equipment and products. Any corrections regarding this technical manual should be submitted in accordance with T.O. 00-5-1.

Throughout this manual the unit will primarily be called the Tank. It may also be called the Storage Tank. Tanks referenced but not covered by this manual will contain additional descriptions. Example: supply tank and receiving tank. Liquid oxygen/nitrogen may be referred to as the product, or abbreviated as LOX/LIN in parts of this manual.

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SAFETY SUMMARY

The following are general safety precautions which are related to liquid oxygen/nitrogen equipment. These are recommended precautions that personnel must understand and apply during many phases of operation and maintenance while using this equipment. Specific precautions will be included in the text for certain potentially hazardous operations in the form of a WARNING or CAUTION statement. The following information appears in the text of this publication and is presented here for emphasis.

WARNING AND CAUTION STATEMENTS

WARNING and CAUTION statements have been strategiaclly placed throughout this text prior to operation or maintenance procedures, practices or conditions considered essential to the protection of personnel (WARNING) or equipment and property (CAUTION). A WARNING and CAUTION will apply each time the related step is repeated. Prior to starting any task, the WARNINGS or CAUTIONS included in the text for the task will be reviewed and understood.

QUALIFIED PERSONNEL

Only qualified personnel shall be authorized to operate and perform maintenance on this equipment.

PROTECTIVE EQUIPMENT

Personnel operating and performing maintenance on this equipment shall wear protective clothing and equipment as directed in T.O. 00-25-172 and applicable AFOSH standards.

DANGEROUS PRESSURES

Pressure systems precautions apply to all ranges of pressure. Care must be taken during testing to ensure that all test connections are proper and tight prior to applying pressure to the test setup. All system components must be compatible with pressure applied. Personnel must be protected by a safety shield or locate at a distance sufficient to prevent injury. Quick disconnects should have mechanical restraints to prevent whipping if they pop loose. Additionally, high pressure flex lines that are not secured should be weighted down (i.e. sand bagged) at approximately four (4) feet intervals to prevent whipping if a connection breaks loose.

SAFETY SUMMARY-CONTINUED

BODILY CONTACT

Never allow liquid oxygen/nitrogen or the piping on the equipment to contact the skin. The extremely low temperatures created by liquid oxygen/nitrogen will immediately freeze the body area and result in severe frostbite.

EMERGENCY TREATMENT OF BODILY CONTACT

In the event of bodily contact with liquid oxygen/nitrogen or the Tank piping, remove the victim from the exposure immediately. Do not attempt to re-warm any bodily parts as this should be accomplished by proper medical personnel. Transport the patient to an emergency room of a hospital or clinic as soon as possible. Keep the patient dry and warm enroute to the emergency room. Upon arrival identify the injury as exposure to liquid oxygen/nitrogen.

UNAUTHORIZED CONTAINERS

Never put liquid oxygen/nitrogen in any container without proper safety devices (e.g. thermos bottle). When heated, liquid oxygen/nitrogen will expand rapidly and build pressures to extremely high levels. The results of pressure buildup without safety devices may result in an explosion.

KEEP AWAY FROM ABSORBENT MATERIALS

Liquid oxygen must be kept away from absorbent materials such as rags, wood, paper, and clothing. These materials may trap the oxygen gas and later be ignited by source of spark or flame.

KEEP AWAY FROM HYDROCARBONS

Liquid oxygen is not compatible with hydrocarbons. Forms of hydrocarbon are oils, greases, gasoline, tar, and asphalt. Liquid oxygen in contact with hydrocarbons present a severe explosive hazard. The equipment, its components, and tools used in maintenance must be kept free of hydrocarbons.

SMOKING

Do not smoke or permit smoking within fifty (50) feet of Tanks in liquid oxygen service. Do not carry sources of flame in the vicinity of Tanks in liquid oxygen service. Use caution in smoking immediately after being exposed to liquid oxygen vapors as these vapors may be still trapped in clothing.

SAFETY SUMMARY-CONTINUED

VENTILATION

Adequate ventilation must be provided for personnel for Tank functions such as transfer operations, filling, draining, purging, painting, welding, brazing, and cleaning.

LIFTING

Equipment used in lifting and moving the Tank must be of sufficient rating to handle the weights involved.

PART CLEANLINESS

All parts used in liquid oxygen service must be kept clean and free of hydrocarbons. Never use shop air to dry clean parts. Ultraviolet lights are used to check parts that have been cleaned. Overexopsure to ultraviolet light can result in conjunctivitis (inflammation of the inner eyelid and eyeball) and possible skin burns which could result in skin cancer.

PURGING

When purging a Tank, all piping and valves become hot enough to burn. Ensure Tank components are at ambient temperatures before attempting handling or removal after purging operation.

WELDING AND BRAZING

Welding or brazing operations produce heat, metal fumes, injurous radiation, metal slag, and airborne particles. Proper equipment must be worn before welding or brazing. Never look directly at the arc when welding or the flame during brazing. Never attempt welding or brazing near Teflon components (e.g. anti-seize tape). Teflon components deteriorate at high temperatures and emit poisonous gases. Proper ventilation is a must when welding or brazing.

TANK VACUUM

Never break the vacuum in the annular space with liquid product in the Tank. The liquid product must be drained.

SAFETY SUMMARY-CONTINUED

CLEANERS/CHEMICALS/PAINTS/PRIMERS

Some cleaners, chemiclas, paints, and primers have adverse effects on skin, eyes, and the respiratory tract. Observe manufacturer's Warning labels and current safety directives. Use only in authorized areas. Unless otherwise indicated in the text, use as described in this TO should not result in any immediate health concerns. Consult the local Bioenvironmental Engineer for specific protection equipment and ventilation requirements.

PAINTING

Paint and coatings may affect skin, eyes, and respiratory functions. Proper ventilation is a must and avoid repeated contact when possible.

WELDING/CUTTING/BRAZING

Welding/cutting/brazing operations produce heat, metal fumes, slag, injurous radiation and airborne particles. Adequate ventilation is required in accordance with AFOSH Standards 161-2. Welding helmets/handshield, welding goggles with proper tinted lenses, apron/jacket, welding gloves and welder's boots are required.

Brazing alloy QQ-B-654, Grade 5, contains 15% to 17% cadmium. Cadmium fumes emitted during brazing operations can cause serious health effects. Silver brazing with this alloy will be performed in an enclosing hood as specified by AFOSH Standard 161-2, Chapter C.6. Coordinate respiratory protection requirements with assigned Bioenvironmental Engineer."

Brazing operations should never be attempted near teflon components as they will deteriorate at temperature of 500^{o}F and emit poisonous gas; make sure that teflon washers are removed from valves and no teflon sealing tape remains on the threads of screwed connections before brazing in the vicinity.

SOLVENTS

Solvents may affect skin, eyes and respiratory tract. Use in a well-ventilated area. Avoid eye and repeated skin contact. Keep away from sparks and flames.

SAFETY SUMMARY-CONTINUED

ISOPROPYL ALCOHOL

Isopropyl alcohol is flammable and may affect skin, eyes and respiratory tract. Use in a well-ventilated area. Avoid prolonged breathing of vapors. Avoid eye and repeated skin contact. Keep away from sparks and flames.

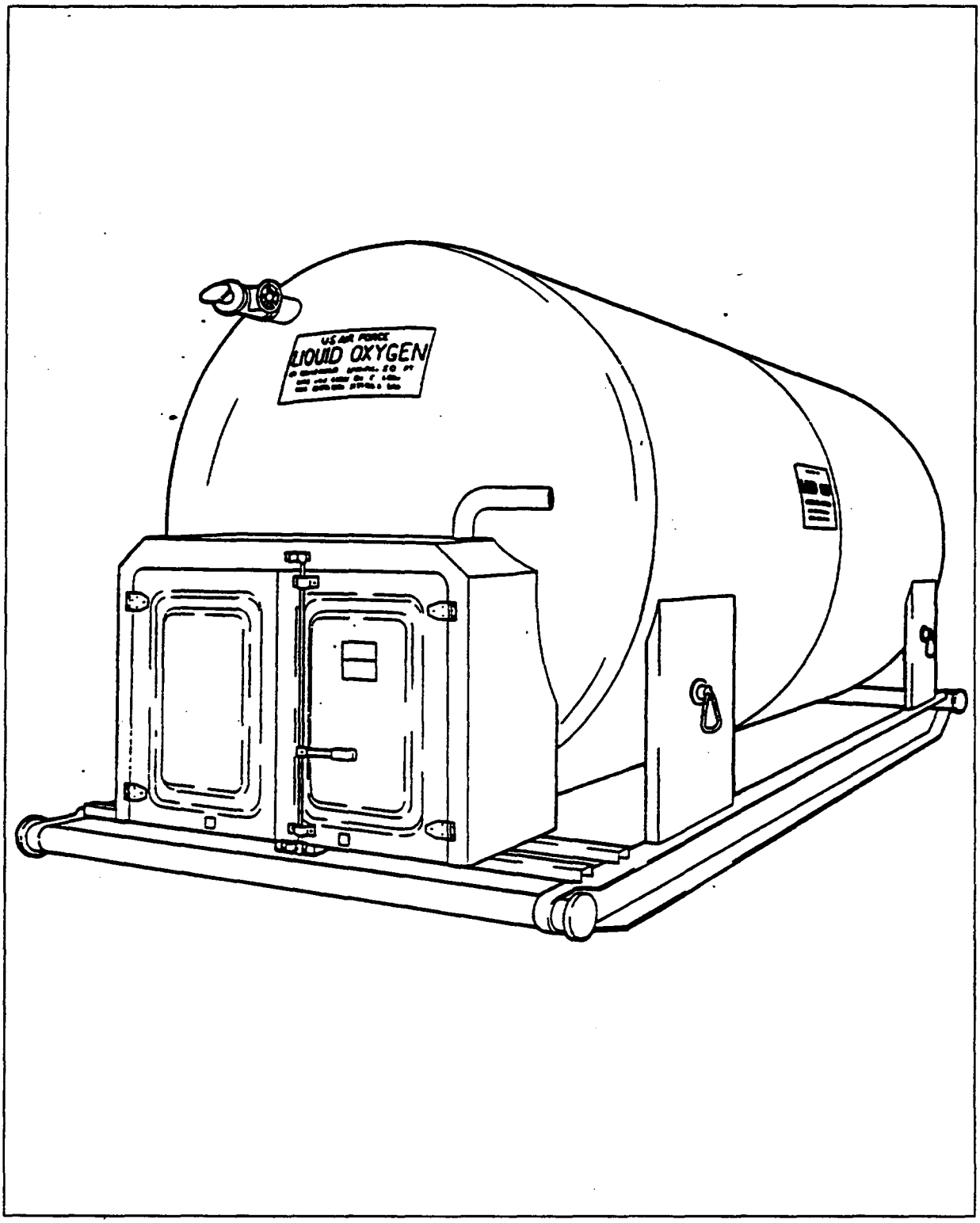


Figure 1-1. Tank, Storage, Liquid Oxygen/Nitrogen, Type TMU-20/E.

SECTION I

INTRODUCTION

-1 GENERAL INFORMATION.

1-1.1 Purpose. This manual contains repair and overhaul instructions for the Type TMU-20/E, Skid Mounted, 5000 Gallon Liquid Oxygen/Nitrogen Storage Tank (see Figure 1-1). The Tank is manufactured to Military Specification MIL-T-27483E (dated 20 April 1967) and so amended under Contract F41608-79-C-1892 modification P-0003 by LOX EQUIPMENT COMPANY, Delphi, Indiana.

1-1.2 Only fully trained and qualified personnel shall be authorized to repair and overhaul any equipment involving liquid oxygen/nitrogen (Refer to T.O. 00-25-172).

1-1.3 Scope. These instructions enable the user to accomplish the following:

a. Disassemble the Tank.

b. Repair the Tank.

c. Repair and replace defective parts.

d. Perform cleaning and inspection procedures.

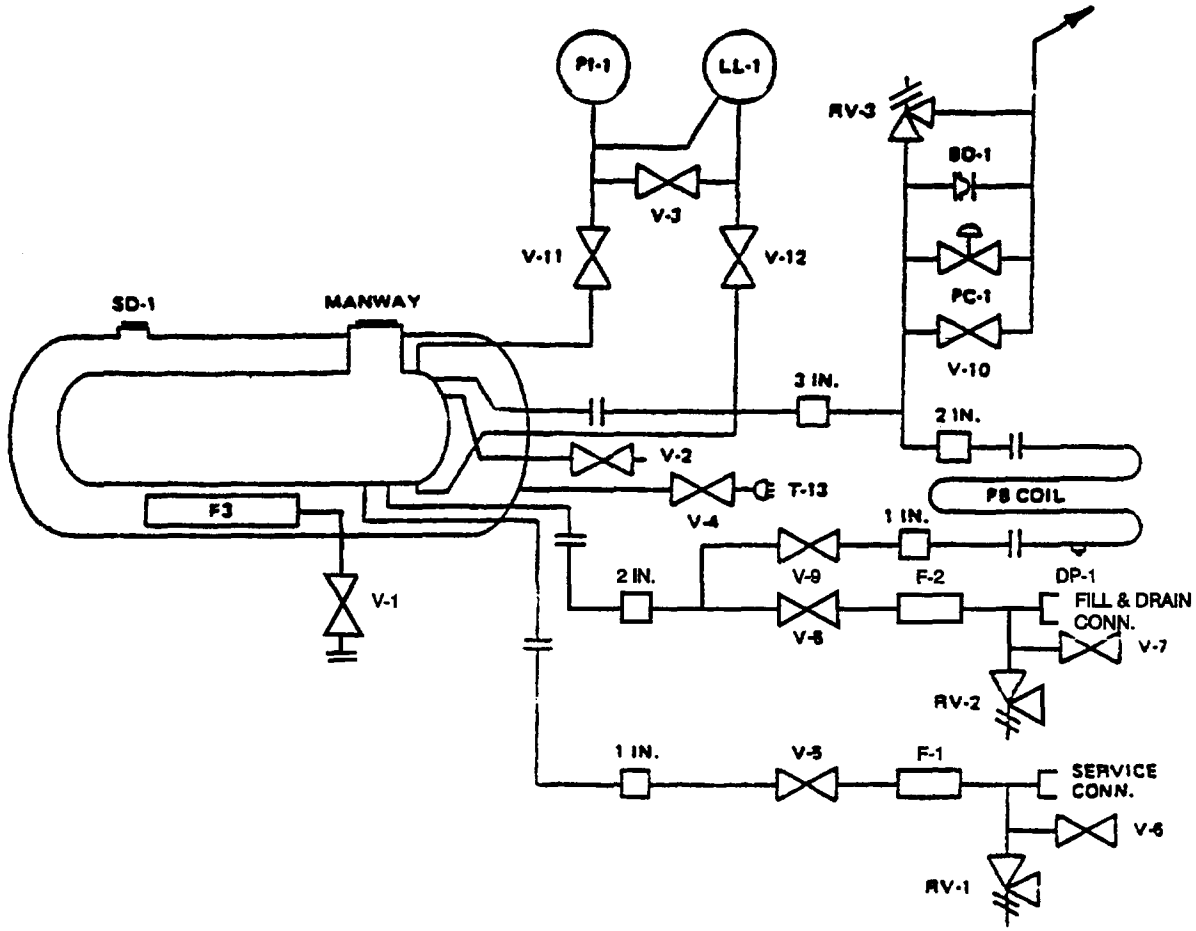
e. Reassemble Tank.

f. Test the Tank to ensure that it is in a serviceable condition.

1-1.4 Repairs. All repairs must be conducted in a well ventilated area to prevent a concentration of vapors from venting and spillage of the product. All safety precautions shall be followed. The necessity of maintaining the cleanliness of parts which come into contact with liquid oxygen cannot be over emphasized.

1-2 PURPOSE OF EQUIPMENT

1-2.1 Physical Description. The Tank is a complete, self-contained unit designed for the storage of liquid product and the transfer of the product into smaller servicing tanks. It will store up to 5000 gallons of product at its atmospheric boiling temperature.



V-1	VALVE - TANK EVACUATION
V-2	VALVE - FULL TRYCOCK
V-3	BALANCE VALVE
V-4	VALVE - VACUUM GAUGE PROTECTIVE
V-5	VALVE - SERVICE
V-6	VALVE - SERVICE LINE BLEED
V-7	VALVE - FILL & DRAIN LINE BLEED
V-8	VALVE - MAIN FILL & DRAIN
V-9	VALVE - PRESS BUILD-UP COIL
V-10	VALVE - TANK VENT
V-11	VALVE - ISOLATION LOW PRESSURE
V-12	VALVE - ISOLATION HIGH PRESSURE
T-13	TUBE - THERMOCOUPLE

BD-1	BURSTING DISC-TANK
F-1	FILTER-SERVICE LINE (25 GPM)
F-2	FILTER-FILL & DRAIN LINE (100 GPM)
F-3	FILTER-TANK VACUUM LINE
LL-1	LIQUID LEVEL INDICATOR-TANK
PI-1	PRESSURE INDICATOR-TANK
RV-1	RELIEF VALVE-SERVICE LINE
RV-2	RELIEF VALVE-FILL & DRAIN LINE
RV-3	RELIEF VALVE-TANK
PC-1	PRESSURE CONTROL VALVE
SD-1	SAFETY DISC TANK ANNULAR SPACE
DP-1	DRAIN PLUG

Figure 1-2. Tank Flow Schematic Diagram

1-2.2 Leading Particulars. A summary of leading particulars for the Tank appears in table 1-1.

1-2.3 Related Publications. This repair and overhaul manual is written for use in conjunction with the Illustrated Parts Breakdown, T.O. 37C2-8-19-4 and the Operation and Maintenance Instructions, T.O. 37C2-8-19-11 and the publications listed therein. Both manuals contain information regarding the same equipment (refer to table 1-2).

1-2.4 Safety Precautions. Safety precautions related to oxygen/nitrogen and this Tank are listed in the Safety Summary. Safety precautions which are related to specific procedures will appear in the text.

Table 1-1. Leading Particulars.

Identification:	Liquid Oxygen/Nitrogen Storage Tank, Type TMU-20/E
Manufacturer:	LOX EQUIPMENT COMPANY - Delphi, Indiana
Part Number(s):	80-507 & SV-50-LN-SK
National Stock Number (NSN)	3655-01-105-8765YD & 3655-01-263-7635YD
Capacity:	
Gross Volume	5338 gallons
Net Volume	5000 gallons
Weight:	
Empty	20,000 pounds
Full (Oxygen)	65,570 pounds
(Nitrogen)	53,745 pounds
Evaporation Rate:	
Oxygen	Less than 1/4 percent per 24 hour day.
Nitrogen	Less than 1/2 percent per 24 hour day.
Overall Dimensions:	
Length	25 ft. - 0 in.
Width	8 ft. - 11 in.
Height	9 ft. - 11-3/4 in.
Operating Pressure (Inner):	55 psig
Maximum Allowable Working Pressure (MAWP):	64 psig
Relief Valve Settings:	
Inner Tank (RV-3)	55
Fill/Drain Line (RV-2)	75 psi
Servicing Line (RV-1)	75 psi
Safety Head Settings:	
Inner Tank (SD-1)	84
Annular Space (SD-2)	84

Table 1-2. Related Publications.

Publication No.	Title
T.O. 00-25-172	Ground Servicing of Aircraft and Static Grounding/Bonding
MIL-STD-1359 (AS)	Cleaning Methods and Procedures for Breathing Oxygen Equipment
T.O. 00-25-107	AFLC Area Support
T.O. 00-25-223	Integrated Pressure Systems and Components
T.O. 00-25-252	Welding High Pressure and Cryogenic Systems
T.O. 00-25-229	Valves and Regulators
T.O. 36G2-3-1	Air Purging Unit, Type GSU-62/M
T.O. 37C2-8-19-11	Liquid Oxygen/Nitrogen Storage Tank, Operation and Service Instructions
T.O. 37C2-8-19-14	Liquid Oxygen/Nitrogen Storage Tank, Illustrated Parts Breakdown
T.O. 37C11-1-1	Cleaning of Pressure Gauges Used on Oxygen Systems
T.O. 37C11-3-1	Vacuum Gauge (Portable), Part No. 15840
T.O. 42B6-1-1	Quality Control of Oxygen
T.O. 35-1-3	Painting and Marking of USAF Aerospace Ground Equipment

SECTION II

SPECIAL TOOLS / TEST EQUIPMENT AND CONSUMABLE MATERIALS

2-1. GENERAL.

2-1.1. Scope. Special tools and test equipment are required for the repair, overhaul and testing of the Tank and its components are listed in Table 2-1. Items recommended (Figures 2-1 and 2-2) are approved tools and test equipment if available. Equivalent items may be used if recommended items are not available.

2-1.2. Consumable Materials. Materials used for repair and overhaul operations are listed in Table 2-2. Approved equivalent tools and materials can be substituted where appropriate.

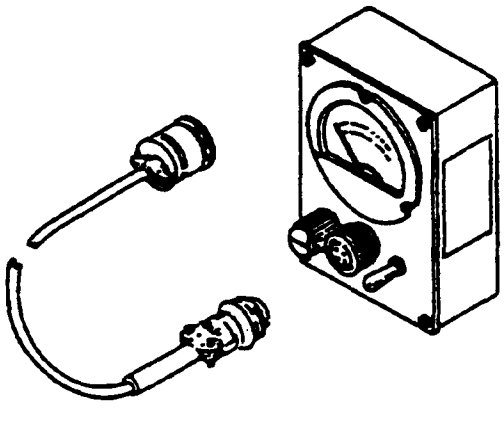


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Figure 2-1. Vacuum Gauge

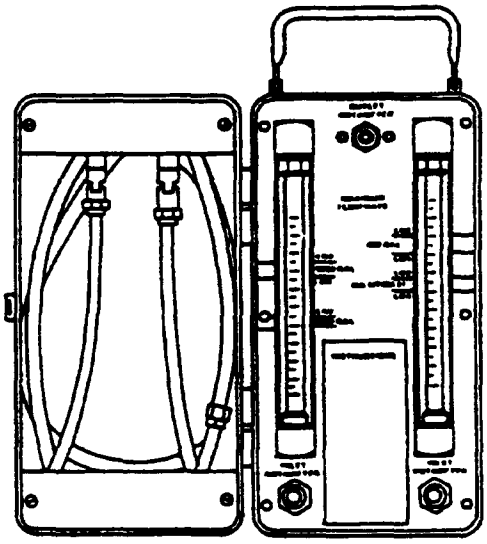

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Figure 2-2. Dual Efficiency Meter

Table 2-1. Special Tools

ITEM	PART NUMBER	USE
Helium Mass Spectrometer	Vecco No. MS-90 or equal	Leak checking
Liquid Oxygen Sampler, Type TTU-131/E	T.O. 33D2-10-60-1	Contaminant testing
Vacuum Pump, Type KTC-21 Electrically Driven, 220/440 vac.	T.O. 34Y5-3-37-3	Pumpdown operations
Air Purging Unit, Type GSU-62/M, 220/440 vac.	T.O. 36G2-3-1 36G2-3-3 36G2-3-4	During tank cleaning
Vacuum Gauge	T.O. 37C11-3-1	Check tank vacuum

Table 2-2. Consumable Materials List.

MATERIAL	SPECIFICATION	REFERENCE
	CLEANING COMPOUNDS	
Detergent	MIL-D-16791, Type 1	T.O. 42C-1-20
Detergent	FED P-C-437	T.O. 1-1-691
Solvent, Trichloro-trifluorethane[2] (Freon)	AFPDI-6814 MIL-C-81302	T.O. 1-1-691
Isopropyl Alcohol	TT-I-735	
	LEAK TEST COMPOUNDS	
Leak Test Compound, Oxygen Use, Temperature 35°F to 160°F	MIL-D-25567, Type I	6850-00-621-1820
Leak Test Compound, Oxygen Use, Temperature 65°F to 35°F	MIL-D-25567, Type II	6850-00-621-1819
Cleaner	MIL-83873	

MATERIAL	SPECIFICATION	REFERENCE
	GRAPHITE AND GREASES	
Grease, Stopcock (LOX compatible)	KEL-F-90	9150-00-475-2760
Grease, Vacuum	DV 6M (MIL-G-27617)	---
	PAINTS	
	Refer to T.O. 35-1-3	
	BRAZING	
Brazing Alloy	QQ-B-654, Grade 5	---
Brazing Flux	O-F-99	---
	MISCELLANEOUS MATERIALS	
Loctite Sealant	MIL-S-22473B, Grade A	8030-00-301-2338
Nitrogen	BB-N-411, Type I, Grade A	6830-00-285-4769
Oxygen	BB-O-925, Type I, Grade A	6830-00-277-1854
Tape, Antiseize, Tetrafluoroethylene[4]	MIL-T-27730	8030-00-889-3534 (1/2 inch) 8030-00-889-3535 (1/4 inch)
Compound, Thread, for use with Oxygen	MIL-T-5542	8030-00-235-3284
Water, demineralized, (total solid content not to exceed 20 ppm by weight)	FSC6800	Commercial

FOOTNOTES

1. Consult MIL-STD-1359 for use of cleaning compounds.

2. Whenever vacuum seals or gaskets are replaced, use only Stop-cock Grease, KEL-F-90. Do not remove vacuum seals, gaskets, etc., merely for grease replacement.

Table 2-3. Personal Protective Equipment for Servicing (Ref. T.O. 00-25-172)

NOMENCLATURE	SPECIFICATION	NSN
Face Shield		4240-00-542-2048
Gloves, Leather, Welder's, Gauntlet, Cuff	KK-G486 Type II	8415-00-268-7860
Gloves, Cloth, Work, Cotton, Knit	MIL-G-1057E	8415-00-964-4760
Gloves, Leather		8415-00-268-7871
Gloves, Inserts, Wool		8415-00-682-6673
Apron		8415-00-715-0450
REF: IAW TO-00-250172		

NOTE

* If Tank entry is required, protective equipment will be used as required by T.O. 00-25-235.

* If specific or unique local conditions are believed to exist that make compliance with the protective clothing or other occupational health requirements specified in this manual unnecessary or impractical, contact the Bioenvironmental Engineer for a detailed evaluation of the operation. On the basis of this evaluation, the Bioenvironmental Engineer will determine the appropriate health precautions required.

SECTION III

DISASSEMBLY

3-1 GENERAL PROCEDURES.

3-1.1 Scope. This section contains instructions for disassembling the Tank. These instructions provide for the removal of all components down to the authorized level of repair. These instructions provide for further dismantling of components where parts may be replaced, cleaned, tested, or inspected.

3-1.2 Preparations and Precautions. Certain general precautions and preparations must be considered prior to disassembly of any assembly, subassembly or component of the Tank. A review of the following paragraphs is recommended before any disassembly is attempted.

a. All procedures must be accomplished in a clean, well-ventilated area of sufficient size to facilitate handling operations of liquid oxygen tanks. An environmentally controlled area is ideal but may be impractical. Maintenance and repair personnel must take every precaution to assure the maximum cleanliness of all parts.

b. Parts removed that may be reused should be cleaned and certified as suitable for liquid oxygen service before reassembly. Use polyethylene bags to protect all clean parts and to seal all piping outlets until ready for assembly.

c. Disassembly of the Tank and its components should be limited to those necessary for repair, replacement, required cleaning, or inspection. Components of the Tank that are removed solely for access to other components should be tagged and laid aside for subsequent reassembly. If removed parts are in contact with either the product or the vacuum, they must be protected against contamination by polyethylene bags and stored in a suitable place for subsequent reassembly.

d. Tanks used in liquid oxygen service and tools in contact with liquid oxygen parts must be kept completely free of hydrocarbon oils and greases.

e. During disassembly and handling of components exercise care to avoid any damage. Use particular care to avoid scratching or otherwise defacing flared tube mating surfaces and valve seats.

f. The Tank may be lifted and moved by crane using slings or cables. Forklifts may also be used to lift the Tank. Always maintain the Tank in a horizontal position when lifting. Refer to the Operational and Maintenance Instructions, T.O. 37C2-8-19-11, for additional lifting instructions.

g. Only appropriate tools for any particular application may be used in disassembly or assembly of the Tank. This will reduce damage, distortion, and breakage of parts.

h. Subassemblies removed intact (e.g. manifolds or valves) shall be supported in a suitable holding fixture or vise during disassembly or assembly.

i. Tag all parts for identification during disassembly. This will prevent confusion of similar parts during Tank assembly.

j. Riveted, photoetched, and adhesive attached (e.g. decals or nameplates) parts should not be removed except for replacement. Nameplates may be removed from valve stems by removing the bolts and nuts which secure the clamps. Taping over decals or nameplates with suitable tape may reduce damage during assembly or disassembly.

k. Remove and discard gaskets and preformed packings (O-Rings) exposed during disassembly. As a general rule, these parts should be replaced during assembly. Exceptions will be noted at appropriate places in this manual.

l. Remove all anti-seize tape from any threaded fitting during disassembly. Remove all particles of the tape and take care that none enters the system.

m. All valves on the Tank are threaded instead of silver-brazed. Globe valve malfunctions can be corrected without removing the valve bodies from the piping manifolds. Exception to this is leakage between the valve body and the piping.

n. The servicing line pressure relief valve (RV-1), fill/drain line pressure relief valve (RV-2), inner shell pressure relief valve (RV-3), level indicator isolation valves (V-11 Vapor and V-12 Liquid), and level indicator equalizer valve (V-3) have threaded connections. These valves can be removed and inspected. If these valves are found to be in an unservicable condition, they should be condemned and replaced on reassembly.

3-2. DISASSEMBLY.

3-2.1 General. Only qualified personnel will be authorized to disassemble or repair the Tank. Safety precautions must be followed.

a. Prior to disassembly the Tank shall be drained in accordance with procedures outlined in T.O. 37C2-8-19-11.

b. After draining. perform the purging procedures outlined in Section V as necessary.

3-2.2 Disassembly Procedures. The disassembly of the Tank is generally in the order of the index numbers assigned to components in Figures 3-1 through 3-14. Instructions first outline procedures for complete disassembly. Since this may not always be desirable, necessary, and practical to effect repairs, procedures are also given for component disassembly. The steps for component disassembly reference steps in the complete disassembly. Disassemble the Tank only to the extent required for replacing defective parts. In some instances, disassembly instructions are included for components which are not disassembled or removed from the Tank except for obvious failure (e.g. vacuum line shutoff valve (V-1)). The instructions for the removal of these items will be preceded by a note of caution to prevent accidental tampering which could delay a mission. The orderly disassembly of the Tank is as follows:

3-2.2.1 Safety Head. (See Figure 3-1). The Safety Head is a relief device designed for the annular space in case of over- pressurization due to inner vessel or plumbing leaks.

a. Removal from outer vessel.

[1] Close tank evacuation valve (V-1), Figure 1-2.

[2] Connect pressurized source of dry nitrogen gas to vacuum line flange.

[3] Connect compound vacuum pressure gauge (0-30 inches of Hg. and 0-30 psi) and pressure regulator valve between nitrogen source and vacuum line flange.

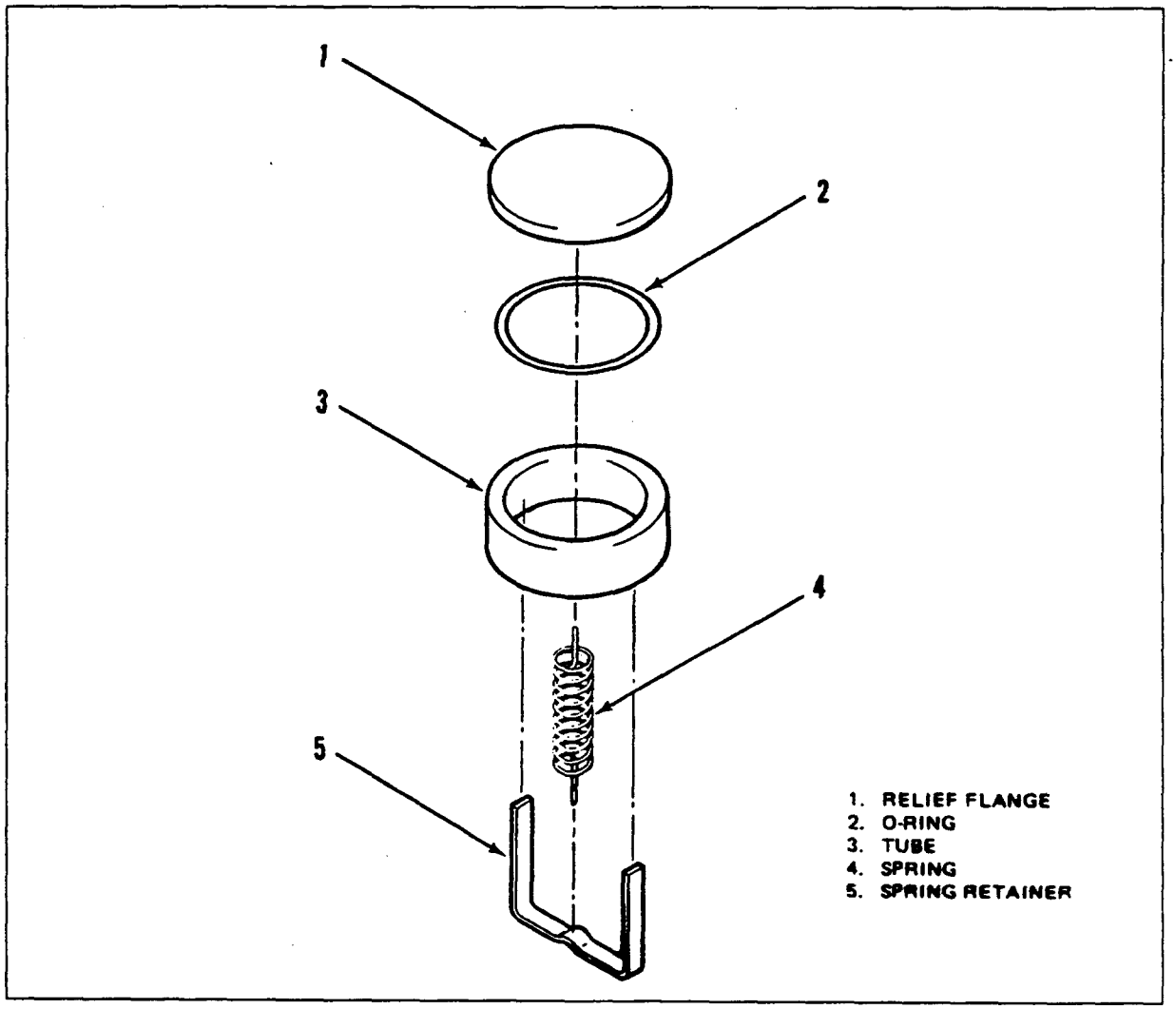


Figure 3-1. Safety Head

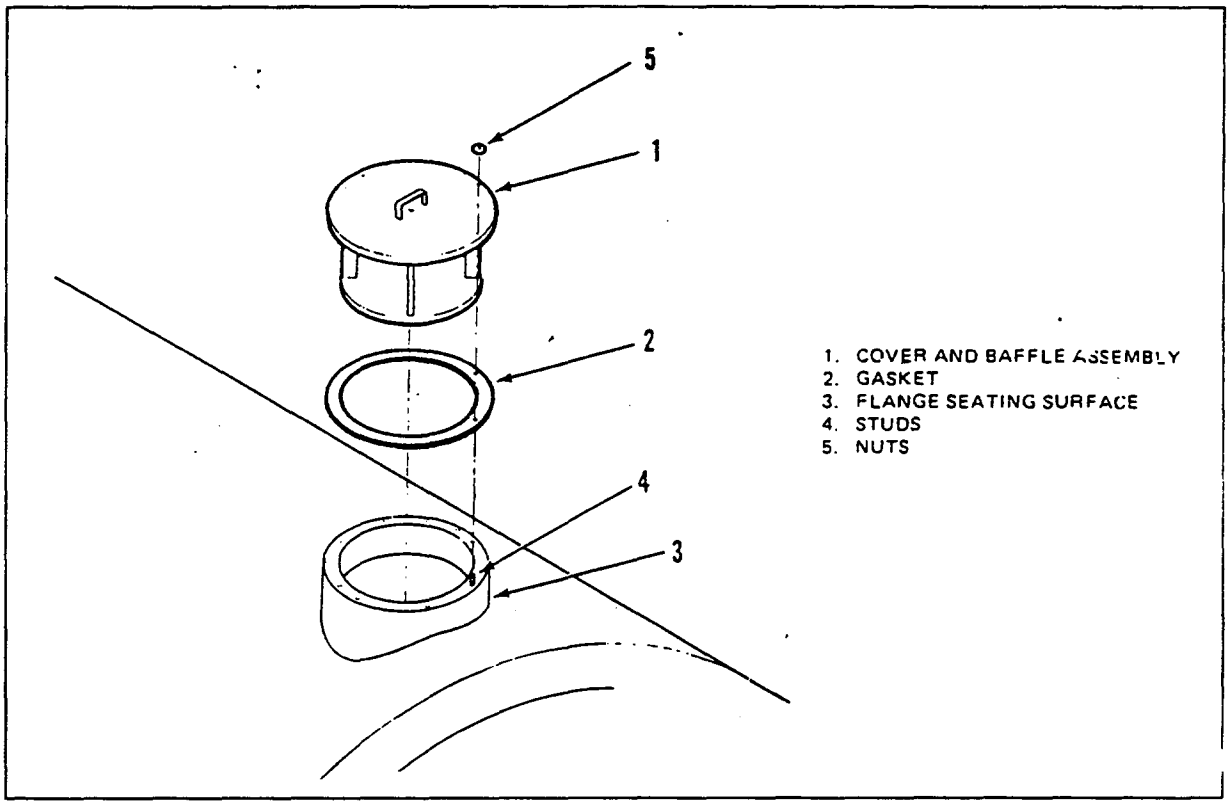


Figure 3-2. Manway and Cover Exploded View

[4] Open tank evacuation valve and vent annulus to 0 inches of Hg. Apply nitrogen gas at 5-10 psi.

[5] Lift relief flange, (1) Figure 3-1, block in open position. Remove O-Ring (2).

[6] Unhook the spring (4) from retainer and set assembly aside.

[7] Cap opening immediately.

3-2.2.2 Manway. (See Figure 3-2). The manway is the opening from the outer vessel to the inner vessel allowing for inspection and cleaning of inner vessel components.

a. Removal of Manway Cover.

[1] Remove the 24, 1/2-inch-20 NF nuts from the studs securing the cover (1) to the Tank and lift the cover assembly from Tank. Seal the assembly in LOX Clean Bag.

[2] Replace the used gasket over the studs and replace nuts on the studs to protect the seating surface and threads during repair.

NOTE

Replace with Evedure silicone bronze nuts only.

[3] Cover and seal opening to maintain LOX cleanliness.

3-2.2.3 Front Cabinet. (See Figure 3-3). This is the fabricated assembly that protects vessel plumbing, controls and indicators.

a. Removal of cabinet from Tank assembly.

[1] Disconnect and remove the vent extension from the Tank vent spool assembly (refer to Figure 1-1). Set aside, to be re-installed as soon as cabinet is removed. Maintain cleanliness while pipes are open.

[2] Remove and retain (bolts, nuts and screws) holding housing to tank and to drain.

[3] With a putty knife or similar tool, break the seal between the neoprene molding and tank head. (Do Not remove the pop rivets holding the molding to cabinet unless damaged). Clean the sealant from the tank head and molding.

[4] Lift the cabinet assembly from the Tank, store where it will not be damaged and replace the vent extension on the vent spool assembly.

[5] If repairs to the cabinet assembly are required, consult the manufacturer's drawing 80-361 for details.

3-2.2.4 Panel Assembly. (See Figure 3-4.) This is the fabricated assembly used to mount controls and indicators.

a. Removal of Panel from Front Cabinet.

[1] Disconnect the swagelok connectors, (9 and 10), spring the tube back and clear of the connectors. Cap or seal the openings.

[2] Remove the screws holding the panel assembly too the foundation and take the entire assembly to a LOX clean room.

[3] The liquid level and pressure gauges can be checked for calibration at this stage by connecting high pressure and low pressure lines to the connectors where the tank lines were removed (refer to Section VII, paragraph 7-2.2).

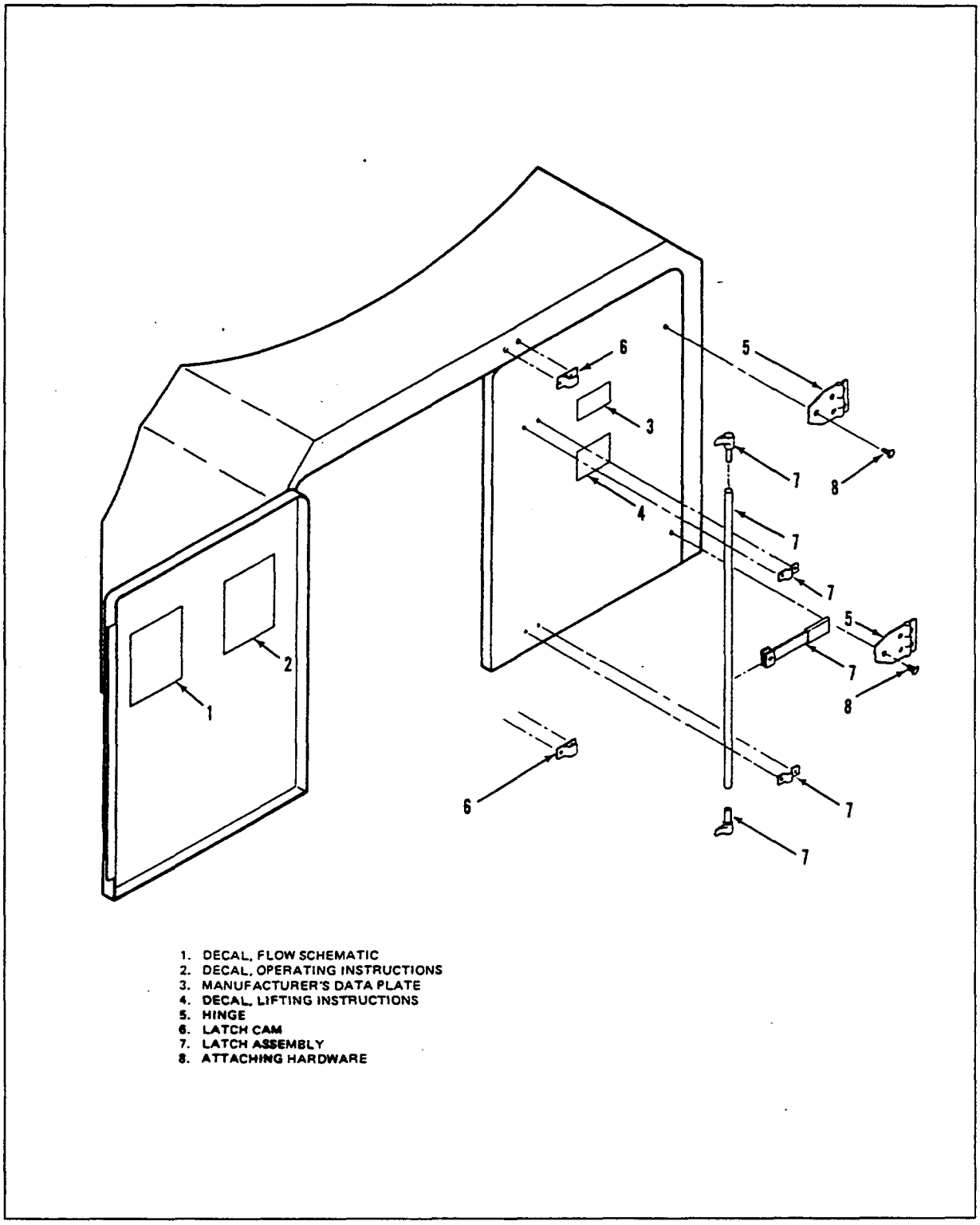
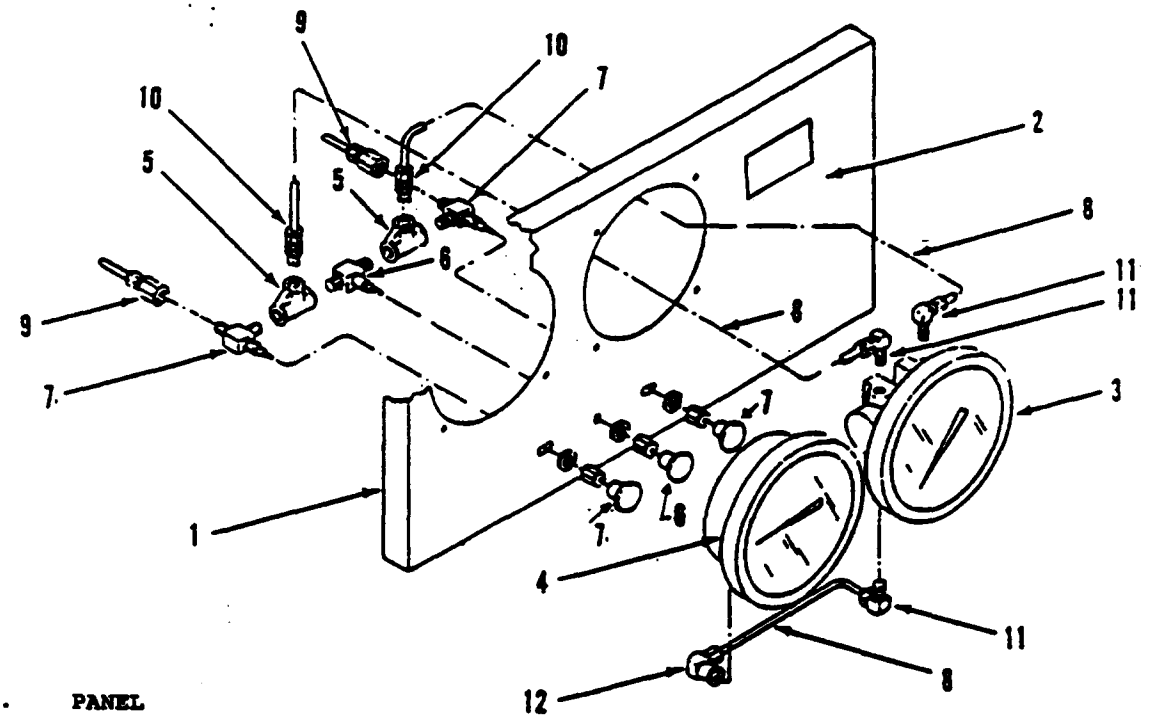


Figure 3-3. Front Cabinet



1.	PANEL	7.	ISOLATION VALVE
2.	NAME PLATE	8.	TUBE, 1/4 IN. OD
3.	LIQUID LEVEL GAUGE	9.	STR. CONNECTOR, 1/4 IN. OD x 1/4 FPT (2)
4.	PRESSURE GAUGE	10.	STR. CONNECTOR, 1/4 IN. OD x 1/4 MPT (2)
5.	PIPE TEE, 1/4 IN. IPS (2)	11.	90° CONNECTOR, 1/4 IN. OD x 1/4 IN. MPT (3)
6.	EQUALIZER VALVE	12.	90° CONNECTOR, 1/4 IN. OD x 1/4 IN. FPT (3)

Figure 3-4. Panel Assembly

[4] If either instrument indicates "out of calibration" it should be forwarded to PMEL calibration laboratory for calibration.

[5] To remove an instrument (always in a LOX Clean Room) disconnect the swagelok connector(s), back the connector(s) out of the instrument and re-assemble on the end of the tube. Cap or seal the connector(s) and the pressure port(s) on the instrument, then remove the screws attaching the instrument to the panel, and lift out the defective instrument which should then be sealed in a plastic bag for return to a calibration facility.

3-2.2.5 Vacuum Indicator Gauge. (Refer to Table 2-1.) Indicator used to check absolute pressure of annular space.

3-2.2.6 Vacuum Line Spool Assembly. (See Figure 3-5). This is the assembly of the diaphragm valve and thermocouple tube.

[1] Close vacuum probe valve and unscrew vacuum probe from elbow (3 and 4, Figure 3-5).

[2] Connect source of pressurized dry nitrogen gas to vacuum probe elbow.

[3] Connect compound vacuum pressure gauge (0-30 inches of Hg. and 0-30 psi) between nitrogen source and vacuum probe valve (2). Pressurize the inner tank to 15 psi.

[4] Open vacuum probe valve and vent annulus to 0 inches of Hg. (min.). A slight positive pressure (1-2 inches of water is desirable).

[5] Remove the blind flange from the tank Evacuation valve (V-1, Figure 1-2), and then open the evacuation valve, being sure that ambient air is not sucked back into the annular space.

[6] The evacuation valve and the internal filter can then be removed as an assembly.

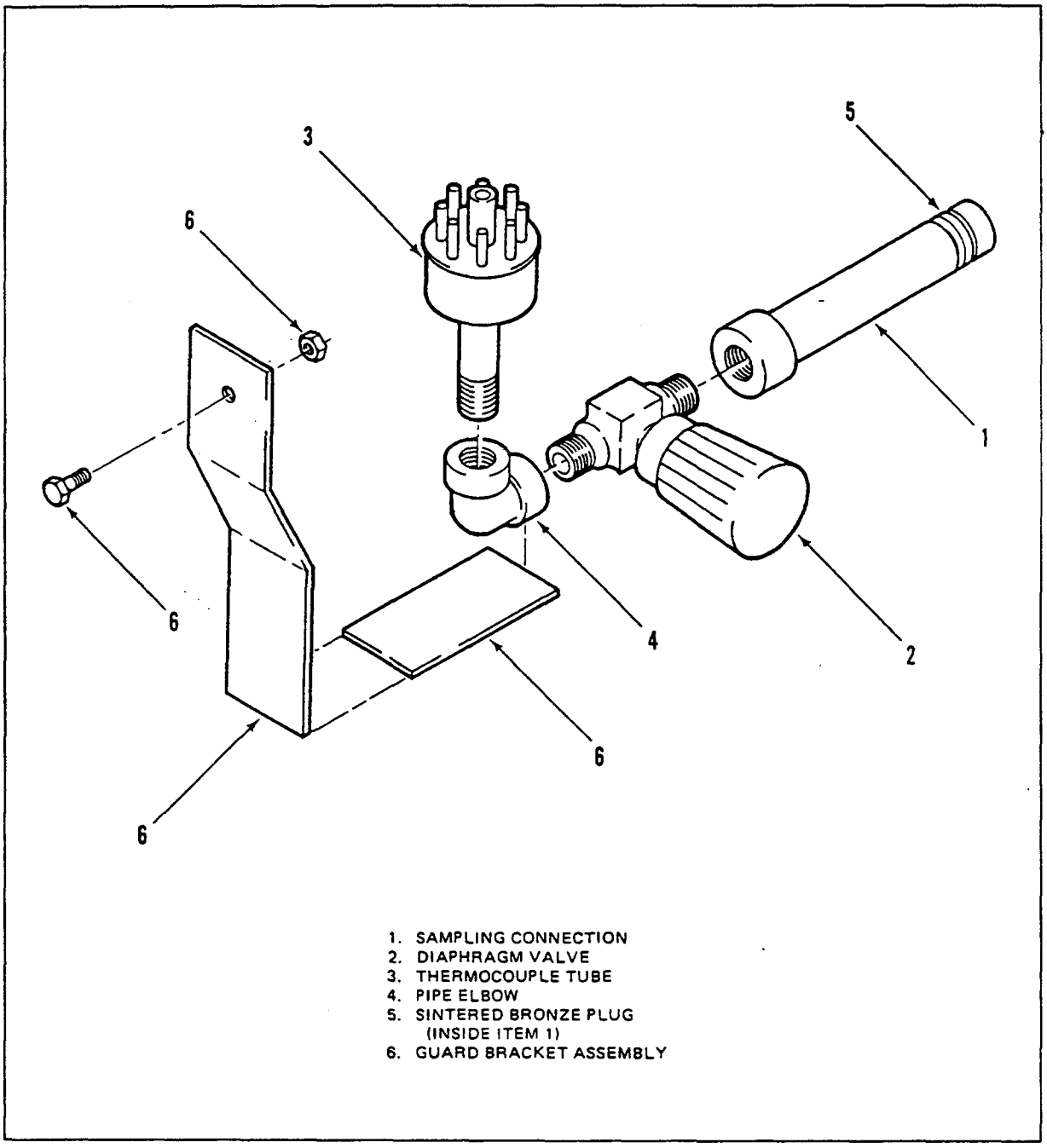


Figure 3-5. Vacuum Thermocouple Spool Assembly

3-2.2.7 Diaphragm Valve. (See Figure 3-5). When repair of the diaphragm valve is indicated, replace the entire unit as an assembly.

3-2.2.8 Servicing Hose. (See Figure 3-6). This hose is used to transfer liquid product to and from storage Tank.

a. Removal of Hose from Storage Tank.

[1] Remove servicing hose from storage tube.

[2] Using spanner wrench, unscrew female half coupling assembly (1) from nipple (2).

[3] Spread S-hook and remove chain assembly (5) from plug (4).

[4] Unscrew plug (4) from nut (7).

[5] Using ring pliers, remove retaining ring (8) from cone (6) and separate cone from nut (7).

[6] Protect threads of nipple (2) and unscrew from metal hose (3).

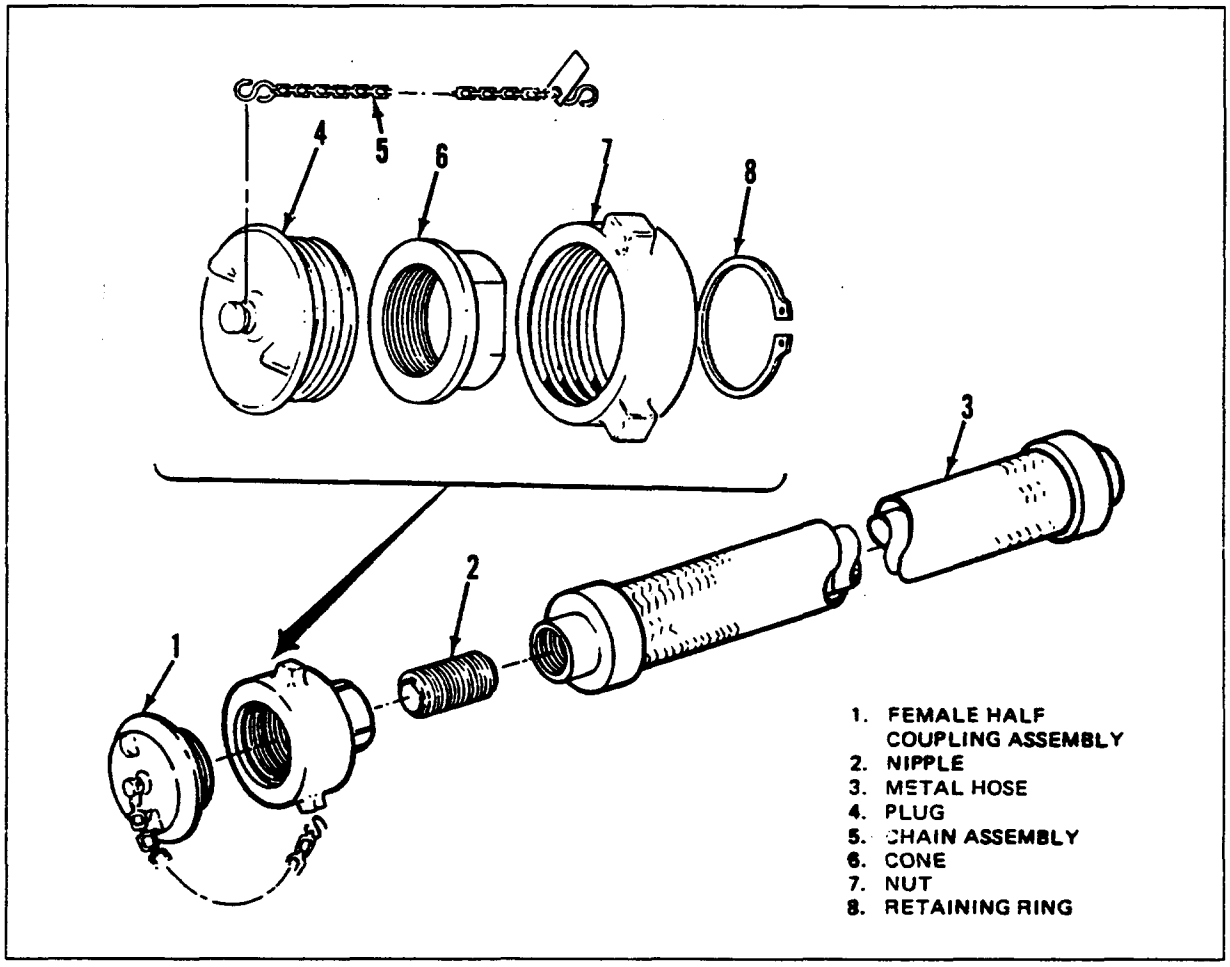


Figure 3-6. Servicing Hose Assembly

3-2.2.9 Coupling Assembly. (See Figure 3-7.) This is the threaded connection on liquid servicing line.

a. Disassembly of coupling assembly.

[1] Obtain coupling assembly.

[2] Spread S-hook and remove chain assembly (2) from cap (1).

[3] Using spanner wrench, unscrew seat (4) from cap (1) and lift gasket (3) from cap.

3-2.2.10 Tank Vent Line Spool Assembly. (See Figure 3-8.) Mates with pressure buildup spool assembly and inner vessel space plumbing and exhausts to atmosphere.

a. Disassembly of tank vent line spool assembly.

[1] To service the burst disc assembly, see Figure 3-9, and paragraph 3-2.2.12.

[2] To service the Tank relief valve, (RV-3) or the pressure control valve (PC-1), proceed as indicated for service of the burst disc assembly, after which either of the two halves may be removed for service.

[3] The Tank vent valve (V-10), is brazed in part of the spool assembly; however the valve can be serviced in place as detailed in paragraph 3-2.2.17, and Figure 3-10.

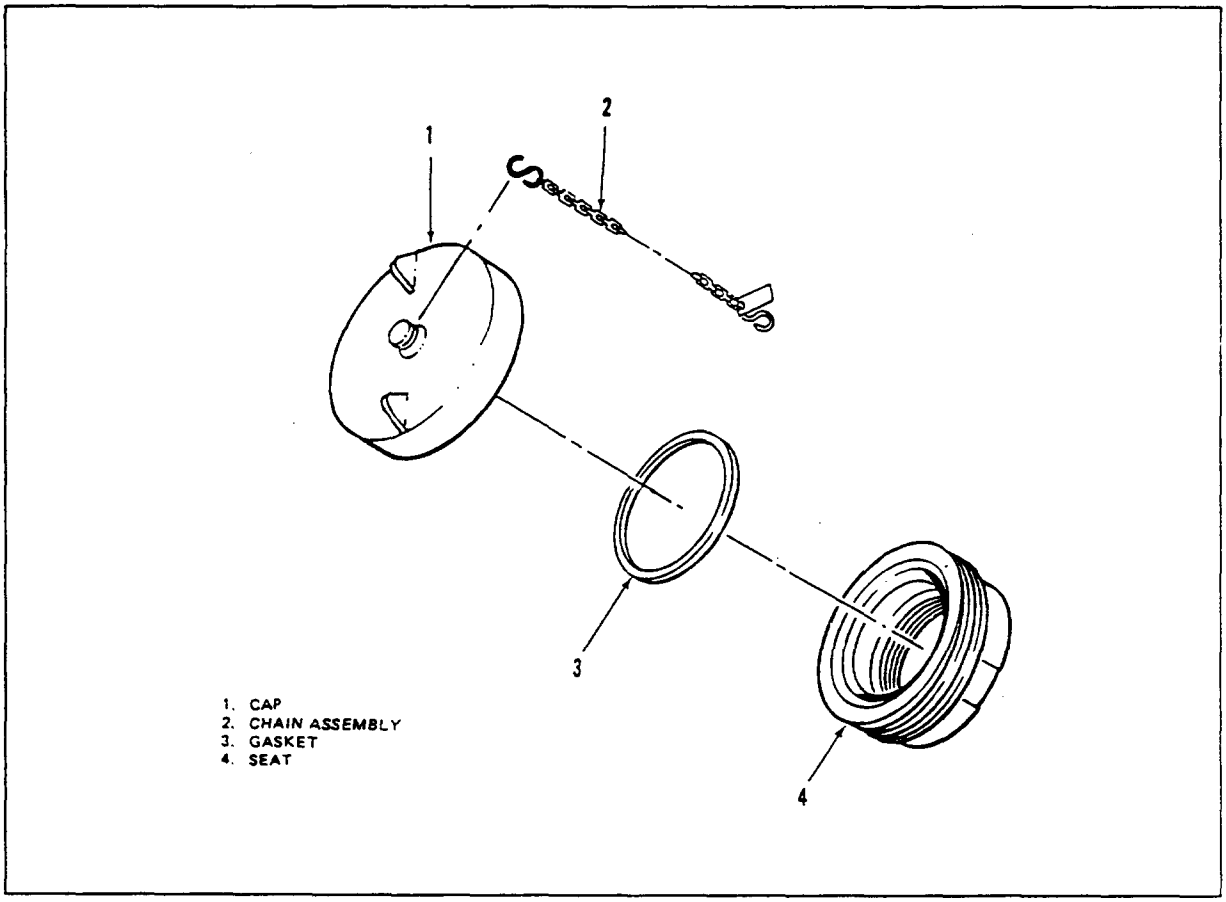
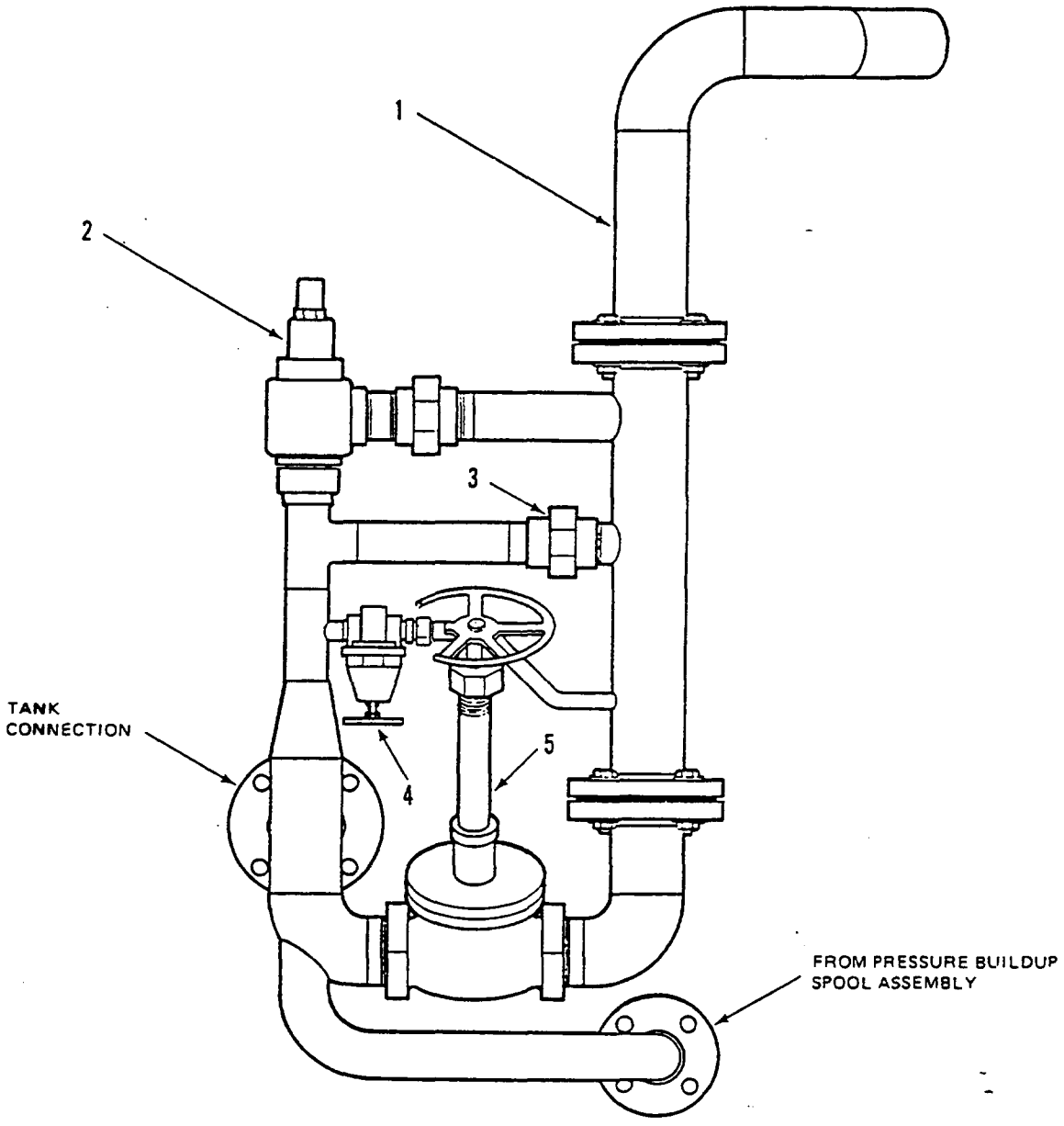


Figure 3-7. Coupling Assembly, Exploded View



1. VENT TAILPIPE
2. TANK RELIEF VALVE, RV-3
3. BURST DISC, BD-1
4. PRESSURE CONTROL VALVE PC-1
5. TANK VENT VALVE V-10

Figure 3-8. Tank Vent Spool Assembly

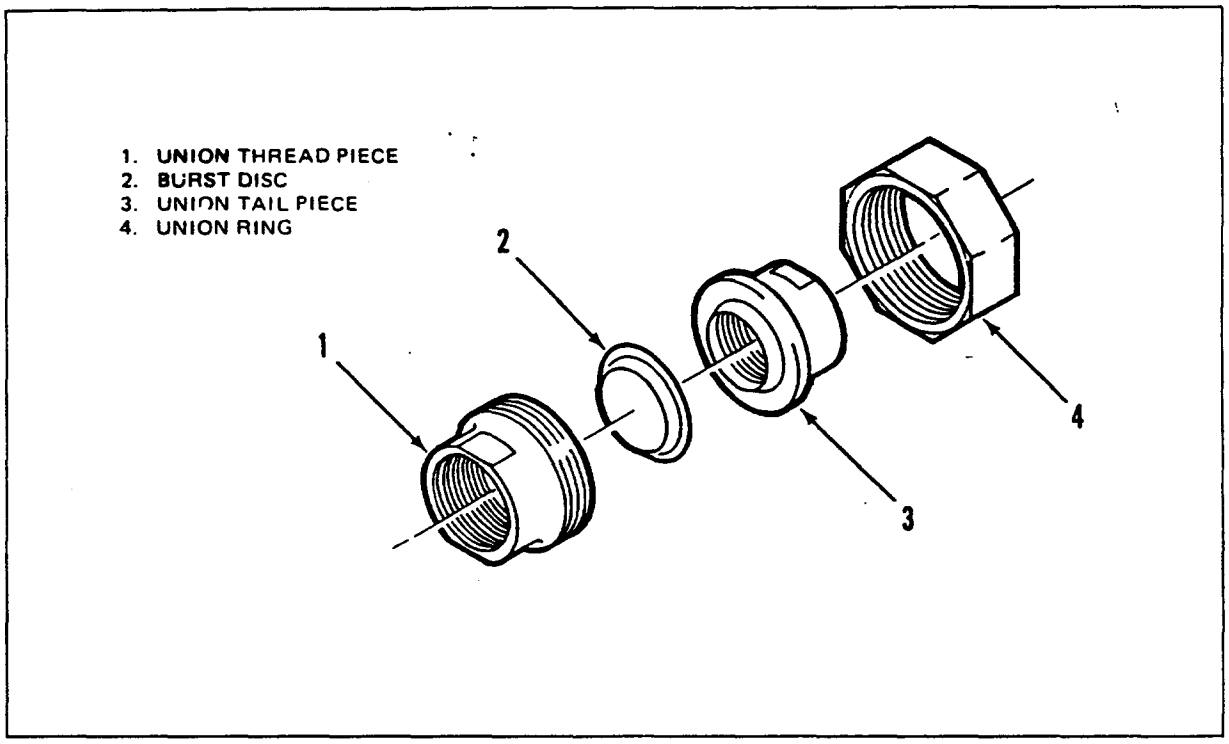


Figure 3-9. Burst Disc Assembly, Exploded View

3-2.2.11 Pressure Control Valve. This is the regulator used to regulate inner vessel pressure. When repair of the pressure control valve is indicated, replace the entire unit as an assembly.

3-2.2.12 Burst Disc Assembly. (Figure 3-9). This is the safety device used to prevent inner vessel overpressurization. In order to service (inspect or replace) the burst disc, it is first necessary to obtain drift space in the tank vent spool assembly (refer to Figure 3-8). Remove the bolts and gasket from the 3 inch flange on the downstream side of the tank vent valve. Back off the union rings from the unions on the downstream of the pressure control valve, the tank relief valve, and on the burst disc assembly. The vent tail pipe assembly can now be shifted laterally to the right, allowing room to remove the burst disc.

3-2.2.13 Globe Valves. (See Figure 3-10).

[1] Service of valves is generally limited to replacement of the disc insert, packing, etc. When more extensive repairs are required, it is more cost effective to replace the entire valve.

[2] To replace packing, remove the handwheel, (1 and 2), then back off and remove the packing nut (4), and packing gland (5). At this point the packing (6) can be removed and replaced with a new set.

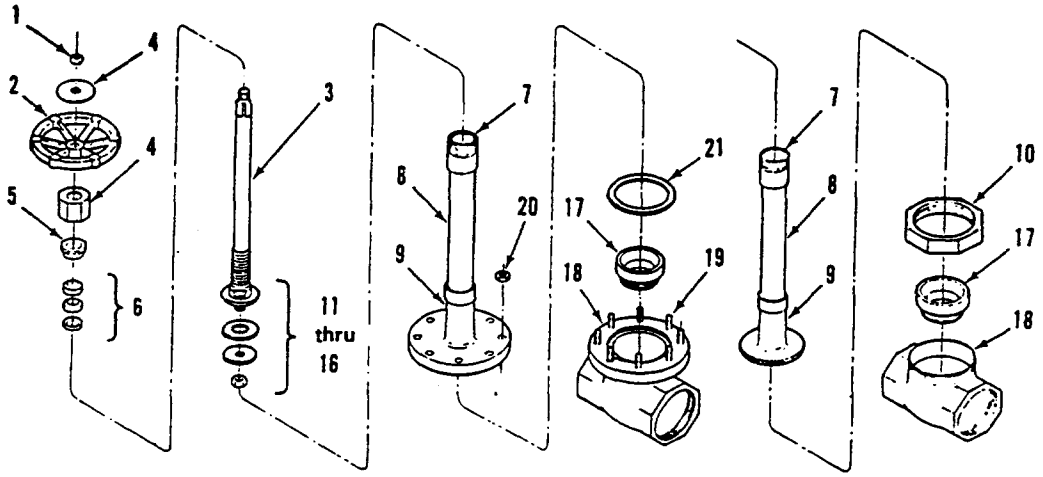
[3] To replace the disc insert (14), unscrew the bonnet ring (10); or remove the nuts (20) from the studs (19), on the larger valves, and lift the bonnet assembly out of the valve. A small disc nut (16) holds the disc plate (15) to the disc assembly. Remove these two parts, after which the disc insert (14) may be replaced.

[4] Do not attempt further repairs in place. If the valve still does not shut off tight, the assembly containing the valve should be removed to a LOX clean facility for major repairs or replacement.

3-2.2.14 Service Line Spool Assembly. (See Figure 3-11.) 25 GPM filtered liquid assembly from storage tank to service unit.

3-2.2.15 Fill and Drain Line Spool Assembly. (See Figure 3-12). 100 GPM filtered liquid transfer assembly for transfer into and out of storage tank. These spool assemblies could be serviced in place, however for maximum safety, they should be removed to a LOX clean facility for service.

[1] The filter cannot be disassembled beyond being removed from the assembly, where it should be cleaned in an ultrasonic cleaner, or replaced with a new filter.



1. WHEEL NUT
2. HANDWHEEL
3. STEM
4. PACKING NUT
5. PACKING GLAND
6. PACKING
7. PACKING SLEEVE
8. EXTENSION TUBE
9. BONNET
10. BONNET RING
11. DISC. LOCKNUT
12. HORSE SHOE RING
13. DISC. HOLDER
14. DISC. INSERT
15. DISC. PLATE
16. DISC. NUT
17. SEAT RING
18. BODY
19. STUD
20. STUD NUT
21. GASKET

Figure 3-10. Typical Valves Sizes 1/4 through 3 Inch

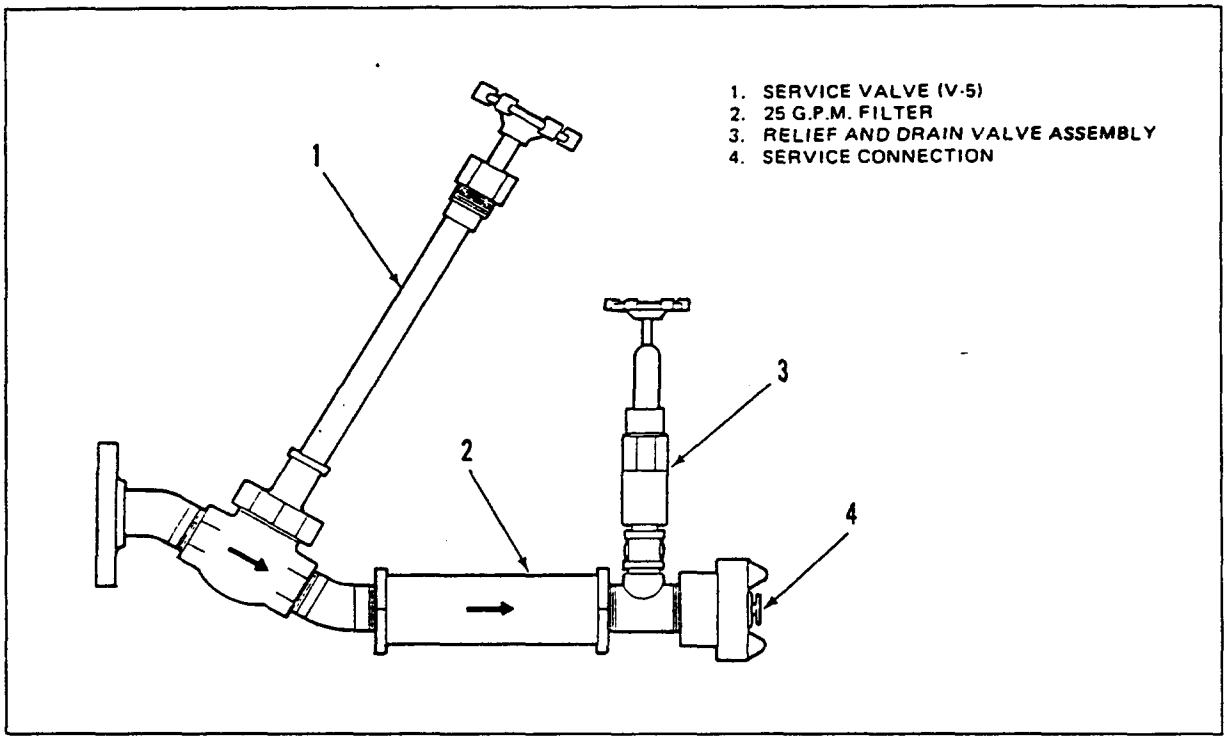


Figure 3-11. Service Line Spool Assembly

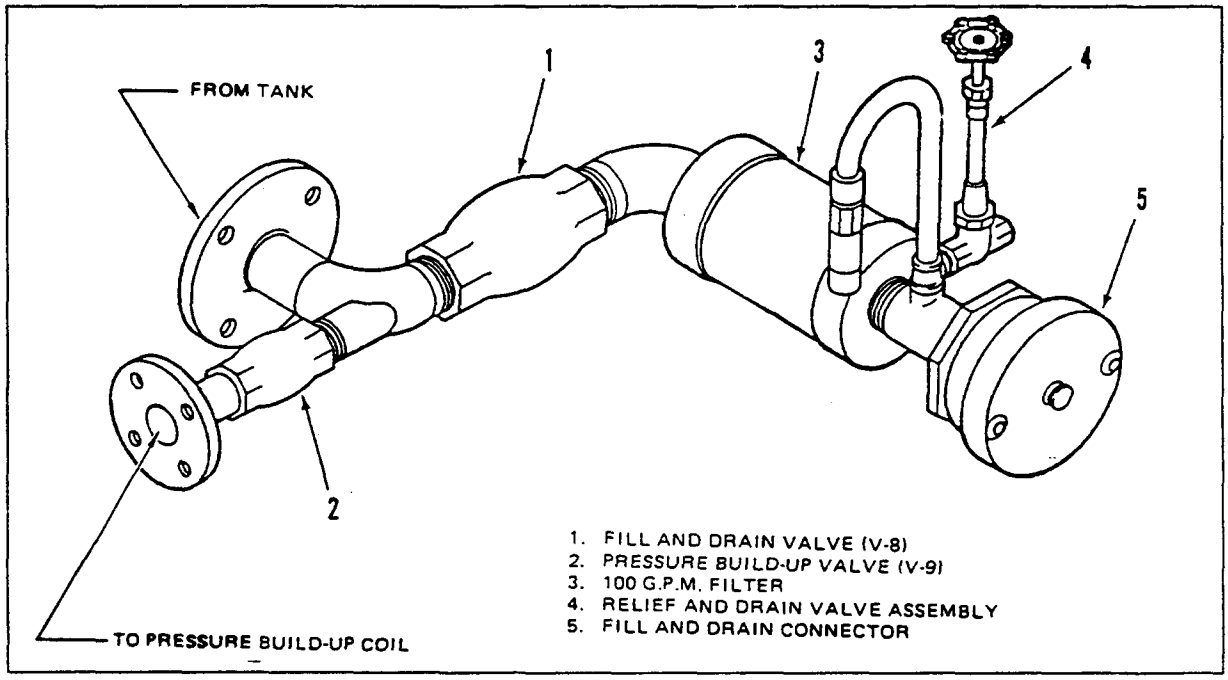


Figure 3-12. Fill and Drain Line Spool Assembly

[2] The valve (See Figure 3-10) can be serviced as per paragraph 3-2.2.13.

[3] The relief and drain assembly can be further disassembled as instructed in paragraph 3-2.2.16.

3-2.2.16 Relief and Drain Spool Assembly. (See Figure 3-13). This is the assembly used to drain service tank completely empty and prevent excess line pressure.

[1] This assembly can be completely disassembled by backing off standard pipe threads. The drain valve can be serviced as detailed in paragraph 3-2.2.13, and the relief valve should be set or adjusted, or replaced with a new or repaired valve.

3-2.2.17 Pressure Build-Up Coil. (See Figure 3-14). This assembly is used to vaporize liquid into gas in order to raise inner vessel pressure.

[1] Remove bolts (1, 5, & 9) by removing nuts (2, 6, & 10), washers (3 & 7) and gaskets (4 & 8) that secure the pressure build-up coil to base.

[2] Lift buil-up coil, supporting laterally, and remove from the side of the Tank.

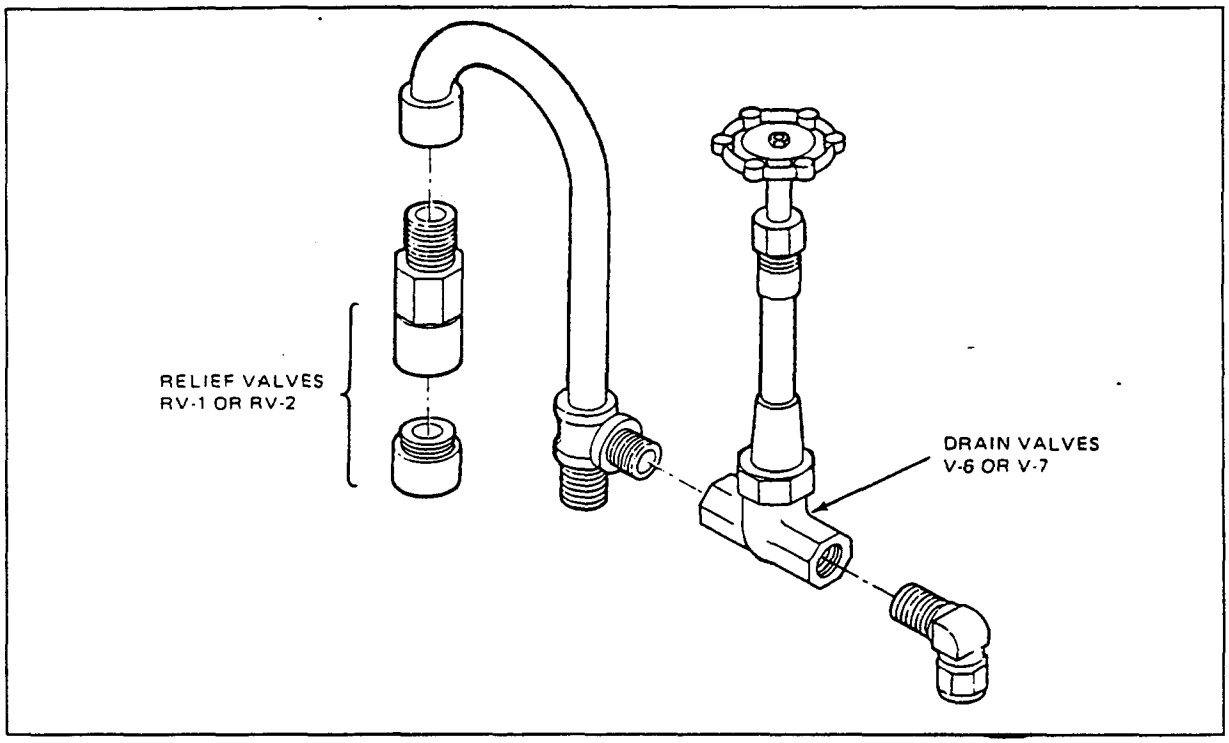


Figure 3-13. Relief and Drain Spool Assembly

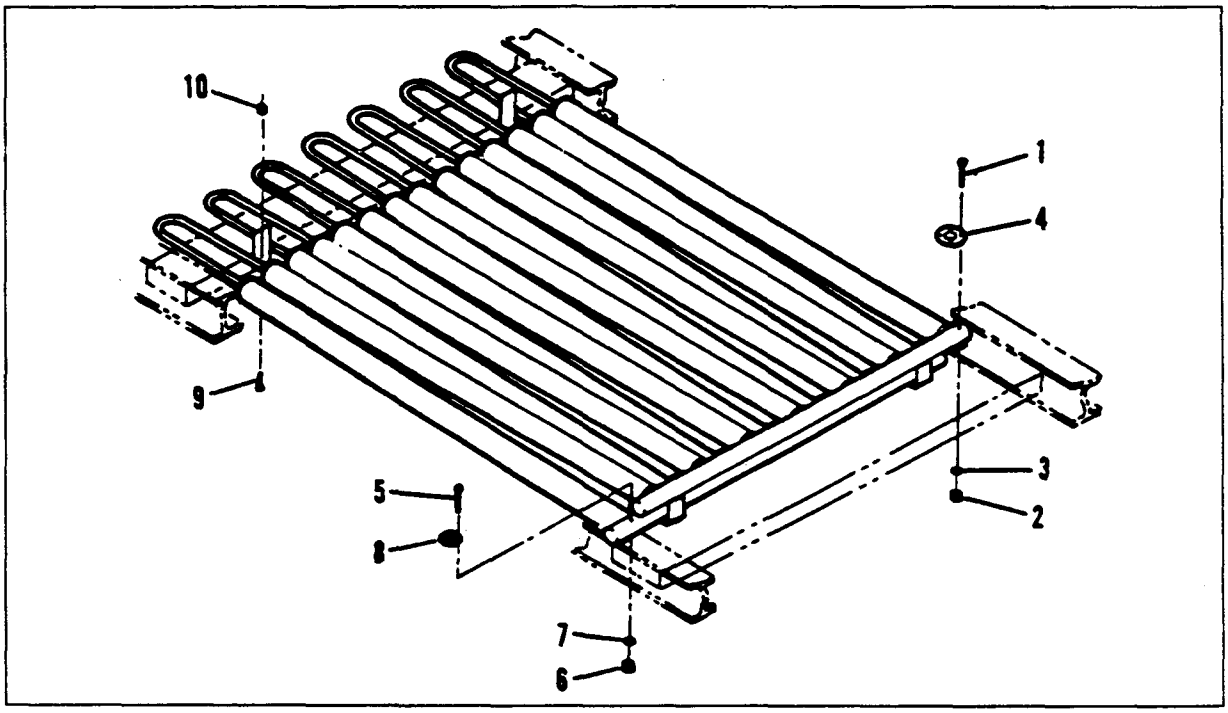


Figure 3-14. Pressure Build-Up Coil

SECTION IV

CLEANING

4-1. GENERAL.

4-1.2. General Cleaning Instructions. General cleaning instructions are provided for all external components of the Tank. External components are herein described as those items which are not incorporated in the LOX circuitry of the Tank and will not be in contact with LOX. Cleaning materials are not described because they differ according to the material composition of the item to be cleaned, refer to T.O. 42C-1-11C for proper solutions.

4-1.3. Decontamination. Decontamination and cleaning procedures for the inner vessel are described in paragraph 4-14.

4-2. EXTERNAL PARTS CLEANING.

WARNING

Steam or vapor pressure cleaning creates hazardous noise levels and severe burn and eye injury potential. Faceshield, rubber apron, rubber boots, ear plugs/muffs and non-asbestos heat resistant gloves will be worn.

a. Solvent degrease non-metallic parts by wiping with a clean cheesecloth dampened in isopropyl alcohol.

b. Clean loose, non-greasy type dirt from exterior surface of components with alkaline cleaner.

c. Steam clean oily painted surfaces.

d. Remove all rust and scale from metallic parts with a stiff brush compatible with the material being cleaned. Clean with cloth dampened in isopropyl alcohol and repaint.

4-3. CLEANING, LOX-HANDLING COMPONENTS.

4-4. MECHANICAL DESCALING. Surfaces which contain scale and all steel or stainless steel welds which will be exposed to gas or liquid and are accessible shall be thoroughly cleaned with a stainless steel wire brush, or abrasive material or any combination of these tools which are compatible with the metal to be cleaned.

NOTE

If Tank entry is required, protective equipment will be used as required by 00-25-235. If specific or unique local conditions are believed to exist that make compliance with the protective clothing or other occupational health requirements specified in this manual unnecessary or impractical, contact the Bioenvironmental Engineer for a detailed evaluation of the operation. On the basis of the evaluation, the Bioenvironmental Engineer will determine the appropriate health precautions required.

4-5. SOLVENT DEGREASING.

a. Immerse component in solvent or fill fully with solvent, Specification P-D-680, Type II or III.

b. Roll or rock component in solvent.

c. Agitate solvent to carry contamination away from part.

d. Continue degreasing operation until all visible contamination is removed from part or for a minimum of three minutes.

4-6. VAPOR DEGREASING.

a. Lifting/lowering speed on hoist will not exceed 10 feet/minute.

b. Parts will be suspended in an attitude to minimize puddling of solvent inside parts.

c. Suspend part in vapor layer of degreaser.

d. Continue degreasing operation until condensation ceases to form on the part.

e. Raise part to freeboard zone (immediately above vapor level) and allow parts to drain.

4-7. ALKALINE CLEANING.

a. Alkaline clean parts which have fine tolerances or may be damaged as a result of acid pickling.

b. Immerse, spray, fill, or scrub parts with alkaline solution until parts are clean.

4-8. DETERGENT DEGREASING.

a. Immerse and scrub part in detergent solution which is maintained at a temperature of 120° - 140°F.

b. Pump circulate solution through the component or over the surface if necessary.

c. Drain solution from component and immediately flush with clean tap water until all traces of detergent have been removed.

4-9. ULTRASONIC CLEANING.

a. Immerse part in ultrasonic cleaning tank.

b. Position part so maximum penetration of all areas is obtained.

c. Remove part from tank and allow solution to drain.

4-10. AMBIENT HIGH TEMPERATURE TAP WATER RINSE.

a. Rinse parts in ambient or high temperature tap water to remove film left by pickling solutions, degreasing, or to remove residue left by mechanical cleaning.

b. Fully immerse part in tap water tank.

c. Scrub part with stiff bristle brush.

d. Rinse part until all visible residual contamination is removed.

e. Rinse part in high temperature tap water (120°F) if ambient tap water rinse does not remove contaminants.

4-11. AMBIENT OR HIGH TEMPERATURE FILTERED TAP WATER RINSE.

a. Rinse parts whose cleaning is rigidly controlled in filtered tap water.

b. Rinse parts which contain residues caused by mechanical or chemical cleaning in filtered tap water.

c. Immerse part in filtered water and scrub part until all visible traces of contamination are removed for a minimum time of five minutes.

d. Rinse part in high temperature (120°F) filtered tap water if ambient temperature filtered tap water rinse does not remove contaminants.

4-12. AMBIENT OR HIGH TEMPERATURE DE-IONIZED WATER RINSE.

a. Rinse parts whose cleaning is rigidly controlled in de-ionized water.

b. Immerse part in ambient temperature de-ionized water tank.

c. Rinse until no evidence of break in the water film on the surface of the part appears in the first five seconds after rinsing of the part out of the rinse bath.

d. Rinse part in high temperature (120°F) de-ionized water if ambient temperature de-ionized water rinse does not remove contaminants.

4-13. DRYING.

4-13.1. Ambient Air Drying. Parts which do not require special handling will be dried by the ambient air method. Place part in area free from contamination and allow to dry. Parts in which fluids may be trapped will not be dried in this method.

4-13.2. Ambient Nitrogen Gas Drying. If parts require purging or cannot be subjected to high temperatures, dry with ambient nitrogen gas, Military Specification MIL-P-27401.

4-13.3. Hot Filtered Nitrogen Gas Drying. Parts receiving more closely controlled cleaning and whose material composition does not lend itself to other forms of drying will be dried with hot filtered nitrogen gas conforming to Military Specification, MIL-P-27401.

4-13.4. Oven Drying. A time/temperature schedule shall be experimentally determined for each type of part. This primarily established according to the material of the part. Parts which have dead end cavities and inaccessible crevices must be dried in the oven. Dry metallic components at a temperature of 212°F, non-metallic components at a temperature of 140°F, to remove all remaining moisture and volatile impurities.

4-14. INNER VESSEL CLEANING. Clean the inner surface of the inner vessel as described in the following steps:

a. Degrease by spraying inside of inner vessel with TURCO 4142 solution, LEEDER 101A solution, or approved equal.

b. Mix twelve ounces of TURCO 4142 solvent per gallon of water and heat to 150° - 170°F.

c. Mix two ounces of LEEDER 101A solvent per gallon of water and maintain at 140°F.

d. Scrub inner surface of inner vessel with nylon bristle brush, if necessary.

e. Spray rinse with tap water filtered to 40 microns until pH of the effluent equals the pH of the influent as indicated by a litmus paper test.

f. Inspect all surfaces of the inner vessel with a 100 watt ultraviolet light to detect fluorescent hydrocarbons. Collect samples of fluorescent areas and laboratory examine for liquid oxygen compatibility, Repeat steps a. through e. above if sample proves to be incompatible with liquid oxygen.

g. Inspect sample of spray rinse effluent for particles. Analyze by millipore inspection method. Maximum particle size shall not exceed 150 microns. Repeat steps a. through e. above if necessary.

h. Spray rinse interior surface with de-ionized water filtered to ten microns and containing less than ten ppm by weight of ionized impurities. Maintain de-ionized water at a temperature of 150°F.

i. Inspect sample of de-ionized water effluent for particles. Analyze by millipore inspection method. Effluent shall not contain nay particles in excess of 150 microns or any solid particles in excess of 75 parts per million by weight. Repeat steps a. through h. if necessary.

j. Clean and inspect manway components as described in a. through i. above. Close manway.

k. Purge inner vessel with hot, dry nitrogen gas, Military Specification MIL-N-6011 or hot, dry air filtered to 40 microns. Continue purging until effluent gas has same dew point as influent gas.

4-15. FILTER CLEANING. Filters on LOX assemblies do not have disposable elements. These units may be cleaned ultrasonically until clogged beyond further use, at which time they must be replaced with a new unit.

a. Immerse filter in ultrasonic cleaner containing detergent solution, for three to five minutes.

b. Remove filter from ultrasonic cleaner. Pump circulate cleaning solution and back flush through filter element for five to seven minutes.

c. Repeat ultrasonic cleaning as described in a. above.

d. Remove filter from ultrasonic cleaner. Pump circulate cleaning solution and forward flush through filter for five to seven minutes. Rotate filter and back flush until effluent meets criteria specified in paragraph 4-16.

e. Dry filter element in a 225° to 250°F oven for five to ten minutes.

4-16. RINSE TEST INSPECTION LIMITS. Rinse test inspection shall be conducted using the millipore method or a 50 mesh screen. Contamination of the effluent sampled shall not exceed the following limits:

Total Filterable Solids Milligrams Per Sq. Ft. Area	Size Microns Per Sq. Ft. Area	No. / Sq. Ft Area
1. Nonfibrous -2.0	300-500	10
	500-1000	2
	Greater than 1000	
2. Fibrous -2.0	750-2000 X 25	20
	2000-6000 X 40	2
	Over 6000 X 40	0

4-17. ULTRAVIOLET (BLACK LIGHT) INSPECTION. Immediately after components have been cleaned, received final flushing, and have been dried or at any time when contamination is suspected, inspect components with black light in the folloing manner:

WARNING

Use only long-wave length (3600 angstrom units or greater) ultraviloet light. Shortwave length ultraviolet rays will burn unprotected eyes.

a. Thoroughly inspect interior and exterior of all parts for contamination.

CAUTION

Do not handle parts with bare hands. A fingerprint or oil from the hands can cause an otherwise clean part to be contaminated.

b. If fluorescent areas appear on component parts, collect samples from the area and perform laboratory analysis. Reclean part if fluorescent substance is incompatible with liquid oxygen.

SECTION V

INSPECTION, REPAIR AND REPLACEMENT

5-1. GENERAL.

5-1.1 Scope. This section outlines the necessary instructions for the inspection, repair, and replacement of components on the Tank. Directions for breaking the vacuum, evacuation of the annular space between the inner and outer shell, leak detection, and painting the Tank are also provided.

5-2 SPECIAL TOOLS AND TEST EQUIPMENT.

5-2.1 The special tools and test equipment required for the performance of the tasks and procedures described in this section are listed in Table 2-1.

5-3 SPECIAL MATERIALS.

5-3.1 The special materials required to perform the procedures outlined in this section are listed in Table 2-2.

5-4 RELATED PUBLICATIONS.

5-4.1 Related publications containing procedures for leak detection, valve repairs, instrument repairs, cleaning methods, packing or seal replacement, liquid oxygen compatible materials, safety requirements, and other types of data are referenced in Table 1-2.

5-5. INSPECTION.

5-5.1 General Inspection. Periodic inspections are performed in accordance with T.O. 37C2-8-1-116-WC-1, Periodic Inspection Work Cards. Operation and maintenance personnel must be aware of discrepancies. The performance of an informal inspection on a monthly basis is highly recommended. These type of general inspections should observe the following:

a. Abrasion: Light scoring or scratching caused by direct contact and friction between two parts or by cleaning with abrasive materials.

b. Burrs: Sharp, rough, upstanding edges.

c. Corrosion: Rust (oxidation) or deterioration of metal, leaving a rough uneven surface.

d. Deformation: Any departure from original surface shape or finish, such as bends, twists, elongation, crushing, flattening, peening, indentation, gouging or structural yielding.

e. Cavitation: Small, deep cavities in the surface.

f. Scoring: Deep scratches caused by friction or abrasive particles.

g. Chafing of Wiring or Insulation: Worn spots in the wiring insulation due to rubbing on other parts.

5-5.2 Periodic Inspection. Complete periodic inspections are performed in accordance with and at the intervals indicated by T.O. 37C2-8-1-116WC-1, Periodic Inspection Work Cards.

5-5.3 Cleanliness Inspection. Cleanliness must become an established habit for all personnel associated with the operation and maintenance of the Tank. The exterior and interior of the unit must meet established criteria for

cleanliness which is designed to protect the Tank, the equipment it services, and the personnel who operate and maintain it. Any discrepancies must be noted and corrected at once. Inspections are as follows:

a. Exterior inspection. Make sure that the Tank exterior is free of contamination by performing the following steps:

[1] Visually inspect for evidence of oils, greases, metal chips, and scaling.

[2] Using ultra-violet light, check ports, couplings, vapor vents, around service and fill piping, and all of the surrounding areas for evidence of hydrocarbons. Clean any fluorescent areas and remove any fluorescent particles.

b. Interior inspection. Perform interior cleanliness inspections only after major overhauls, when contamination is suspected, and before a Tank is placed into service after long term storage. DO NOT PERFORM THE INTERIOR CLEANLINESS TEST UNNECESSARILY as it involves filling the Tank 90% full of liquid nitrogen. Conduct the test as follows:

[1] Fill the Tank 90% to its designed capacity with pre-filtered liquid nitrogen. Accomplish the filling through the fill/drain coupling.

[2] Allow the Tank to stabilize for a minimum of two (2) hours undisturbed.

[3] Obtain a Millipore membrane filter, weigh it, record the weight, and place the filter in a Millipore filter holder.

[4] Remove the protective cap from the fill/drain lien and attach the filter holder in its place.

[5] Using a suitable dewar to receive the liquid nitrogen discharges through the filter holder, open the fill/drain line shutoff valve (V-5) and allow at least one (1) liter of product to pass through the line and filter.

[6] Detach the filter holder and remove the filter element. Dry the filter thoroughly. Examine it for particulate matter, weigh it for total solids, and visually examine it with a calibrated loupe.

(a) No total solid wit a dimension greater tha 6000 microns will be allowed.

(b) No fibrous particle with a length greater than 6000 microns will be allowed.

(c) No more than 25 milligrmas of both solid and fibrous particles will be allowed.

[7] If the total material, solid or fibrous, exceeds the above specified requirements, the remaining liquid will be discharged. Discharge is made through the fill/drain line. The Tank is flushed with liquid nitrogen until the total amounts of foreign matter fall within the above outlined criteria.

5-6. REPAIR AND REPLACEMENT.

5-6.1 General. Most repairs consist of removal and replacement of worn or damaged parts. These repairs are determined by visual inspection. Special instructions are presented in the following paragraphs for individual components. Some inspection notes are included with the instructions to clarify the need or facilitate the replacement procedures. Replace all items determined by inspection to be unserviceable. The following rules may be followed:

a. Threaded Components. If threads are nicked, but not deformed, they may be re-threaded using suitable taps and dies. Small nicks may be chased with small file.

b. Nuts. File deformed or nicked wrench flats to proper contours if the nut itself is not deformed.

c. Corrosion. Remove corrosion by sanding lightly with a light grade of sandpaper or emery cloth.

d. Gaskets and Packings (O-Rings). Replace all damaged and worn gaskets and packings exposed during disassembly. Certain packings must be replaced on reassembly (as noted in the disassembly and assembly procedures).

e. Fasteners. Replace nuts, nutplate screws, bolts and other threaded fasteners if threads and wrench flats are not repairable. Replace missing or damaged rivets.

f. Flared Tubes and Flared Tube Fittings. Flared tube assemblies, tubes, and fittings should be replaced only if repair is impossible. Be sure to inspect flared surfaces for cracks and deformation. Check compression nuts and sleeves.

NOTE

Scratched flared-tube surfaces and stainless steel fitting surfaces may often be repaired by sanding lightly with a fine abrasive material.

g. Labels, Decals, and Nameplates. Labels, decals, and nameplates which have become illegible or partially defaced must be replaced. Check nameplate attachments. Replace loose or deformed rivets.

h. Globe Valves. The servicing line shutoff valve (V-5), servicing line drain valve (V-6), fill/drain line shutoff valve (V-7), fill/drain line drain valve (V-8), pressure buildup control valve (V-9), vapor vent line shutoff valve (V-10), and the full trycock valve (V-2) should be inspected. Check for deformed packings, worn discs, nicked valve disc assemblies.

[1] Repair of these valves should be limited to the replacement of worn or damaged parts. Internal leakage through a valve is usually the result of a faulty sealing disc or damaged seat ring. External leakage at the top of the valve bonnet is usually the result of a damaged or worn packing.

[2] If the valve leaks externally at the top of the bonnet, try and tighten the packing nut. If leakage is at the bottom of the bonnet, try and tighten the bonnet nut.

[3] Globe valves are threaded on the manifold sections using antiseize tape. The globe valves can be rebuilt without disassembling the body. If the body is damaged or

leaking at the manifold threads, then removal of a body will be required. Replacement will depend upon the reparability of the body.

i. Instrumentation Valves. The liquid and vapor level indicator isolation valves (V-11 and V-12) and the level indicator equalizer valve (V-3) are more practically replaced than repaired. Dispose of the damaged valves through the usual channels.

CAUTION

DO NOT OPERATE, REMOVE, OR ATTEMPT TO REPAIR the vacuum indicator shutoff valve (V-2) or the vacuum line shutoff valve (V-1) during routine inspections.

j. Vacuum Valves. The vacuum indicator valve (V-2) should only be opened during vacuum efficiency tests. The vacuum line shutoff valve (V-1) should only be opened to evacuate the annular space. If these valves are determined to be defective, replacement should be with valves of known integrity. Removal should only take place after breaking the vacuum and replacing it with nitrogen gas.

k. Tank Pressure Relief Valve. The Tank pressure relief valve (RV-3) is a sealed (ASME Code) unit. Attempt no repairs or adjustments. Indications of leakage is constant venting, frosted tubing, or the inability to achieve pressure buildup for product transfer. If leakage is suspected, replace the valve and dispose of it through normal channels. A method for testing the valve is outlines in Section VIII.

l. Fill/Drain and Service Pressure Relief Valves. The fill/drain line pressure relief valve (RV-2) and the servicing line pressure relief valve (RV-1) are safety devices to relieve pressure trapped between shutoff points in the respective lines. Repair of these valves should be limited to disassembly and cleaning. Replace the valve if the seal is permanently deformed, cracked, damaged, or the mating surfaces are scored or pitted. Testing procedures for the determination of relief pressure appears in Section VIII.

m. Safety Heads. Failure of the inner shell safety head (SD-1) is usually indicated by a failure to achieve pressure buildup for product transfer, frosted vent lines, and constant venting not associated with the inner shell pressure relief valve (RV-3) or the vapor vent line shutoff valve (V-10). Replacement of the safety head should be with a new unit.

n. Fill/Drain and Service Line Filters. Filters should be replaced whenever they appear to restrict the flow of product. Procedures for the removal and replacement of the line filters appear in Section V of the Operation and Maintenance Instructions, T.O. 37C2-8-19-11. The arrow on the filters should point in the direction of the line of flow. The service line flow is away from the Tank and the fill/drain flow is towards the Tank.

o. Indicators. Defective indicators are located in the control panel. Indicators are generally repaired when the Tank has been drained and purged. The Tank liquid level indicator can be changed by isolating it using the level indicator isolation valves (Vapor V-11 and Liquid V-12). Calibration information for the Tank indicators is found in T.O. 33K-1-100. The local Precision Management Equipment Laboratory (PMEL) is responsible for calibration.. Consult

with the cognizant PMEL office on forwarding an indicator or calibration. Follow their instructions for handling and packaging.

5-7. WELDING AND BRAZING.

5-7.1 All welding on the storage tank assembly shall be accomplished by welders certified in accordance with MIL-STD-1595 using standard weld practices and procedures (reference T.O. 00-25-224).

a. Tank Shell. Although welding on the tank shell is not normally accomplished at base level, the method and personnel required are included to prevent mission delay or work stoppage. All welding on the tank shell will be accomplished by welders certified in accordance with MIL-STD-1595 using TIG weld only (reference T.O. 00-25-244).

b. Frame/Skid. Welding on frame and/or skid members shall be electrically welded at any level of maintenance where qualified personnel and equipment is available.

c. Brazing. (Silver brazed piping assemblies). The area of all brazed connections, over which silver brazing alloy will be flowed, must be cleaned and bright before brazing operations. Undesirable residue will be removed with emery cloth or wire brush. It is necessary that a means be provided to prevent oxidation during the brazing operation. After cleaning the surfaces to be joined to bright metal, a thin coating of brazing flux (Specification O-F-99, grade compatible to materials being joined) shall be brushed over both surfaces being joined, exercising caution to avoid any flux being extruded into the bore of the pipe or fitting, or where the excess could not be easily removed by cleaning after completion of the joint. After the joint is assembled and before heating, apply a second thin coating of flux over the fillet on the outside where the brazing alloy will be admitted. A joint should be brazed shortly after the application of the flux, and before the flux has been allowed to dry and flake off. If for any reason the flux becomes dry before starting to heat the joint, the joint should be disassembled, cleaned, and refluxed before proceeding.

d. Brazing Alloy. The preferred brazing alloy is Federal Specification QQ-B-654, Grade 5. Other grades may be used (if compatible to the metals being joined) when a different melting temperature is required, as in repairing a previously brazed joint.

e. Procedure. Using an oxyacetylene torch with a brazing tip adjusted to a slightly reduced flame (a short white "feather" over a blunt blue cone to indicate a shortage of oxygen and an excess of acetylene), heat the area to be joined until the water has evaporated from the flux elements have melted to a thick syrupy glass. Avoid blowing the flux away from the joint with the force of the flame and avoid overheating or spot heating. If possible, heat the male piece sooner than the female piece as this will draw excess flux to the surface. If, during the heating process, a portion of the joint becomes free of flux, causing a "burn" (oxidation), the joint should be cooled, disassembled, cleaned and re-fluxed before proceeding. When all of the flux is melted and fluid, touch the face of the joint with a piece of cleaned (and preferably fluxed) brazing alloy. Continue to heat the joint until the fillet and/or brazing alloy has been drawn into the joint by capillary attraction. As long as the clearance between the parts is maintained at less than 0.003 inch (cold fit up), capillary attraction

will prevail over gravity and brazing alloy can be drawn to any position of the joint by heating without regard to the horizontal or vertical position of the assembly.

CAUTION

Take extreme care to avoid overheating adjacent lines and fittings; otherwise, a series of leaks may result.

5-8. BREAKING THE ANNULUS VACUUM.

5-8.1 Repairs. When repairs to the outer shell or piping must be performed which will affect the status of the annular space the vacuum must be replaced with a nitrogen atmosphere. NO POSITIVE PRESSURE MAY BE APPLIED and the nitrogen gas must be drawn into the space according to the following procedures:

a. The vacuum line shutoff valve (V-1) is located at the top rear of the outer shell on the Tank.

b. Remove the protective cap and gasket on V-1.

c. Connect a source of low pressure nitrogen gas (Specification BB-N-411, Grade A, Type 1) to the flange orifice. Regulate the nitrogen source to 2 to 3 psig.

d. Open the nitrogen source service valve. Slowly open V-1 and allow the nitrogen to be drawn into the annular space.

e. When the nitrogen flow stops, close the nitrogen source valve and V-1.

f. Disconnect the nitrogen source from V-1.

g. Reassemble the gasket and protective cap.

5-9. TANK ANNULUS EVACUATION.

5-9.1 Evacuation. Deterioration of the annulus vacuum over a period of time is normal. The periodic inspection record will give an indication of the annulus condition. A warm Tank will have a slightly higher pressure indication in comparison to a cold Tank. This condition does not necessarily indicate a vacuum loss but a sudden loss may indicate leakage. A thorough and complete inspection will probably determine the cause.

CAUTION

Do not attempt to evacuate the Tank annular space until the cause of the vacuum loss has been determined and if necessary, repaired.

a. Determine the Tank annulus vacuum level following the procedure referenced in Section VI, Testing. After the test, close the vacuum indicator shutoff valve (V-4) (Figure 1-2).

b. The vacuum line shutoff valve (V-1) is located at the top of the outer shell on the Tank.

c. Remove the protective cap and gasket on V-1.

d. Connect a hose from the vacuum pump to the flange orifice.

e. Start the vacuum pump and read the vacuum level at the pump. It must be below 5 microns before the pump valve is opened. Record the vacuum level.

CAUTION

TAKE CARE TO AVOID ACCIDENTAL SHUT-OFF OF THE VACUUM PUMP DURING EVACUATION. Vacuum loss due to oil ingestion will be immediate and the TANK MUST BE CONDEMNED AS UNSERVICEABLE.

f. Slowly open the pump valve to the vacuum hose for approximately ten (10) minutes. Record the vacuum level in the hose. If should not be more than three (3) microns greater than the level recorded at the pump.

g. Slowly open V-1. There may be a rise in the hose vacuum level which is normal.

h. After four (4) hours of pumping, there should be a large drop in the hose vacuum which will indicate there are no leaks in the system.

i. Observe and record the vacuum level indicated by a portable gauge attached to the vacuum sensor inside the control housing. V-2 must be open to obtain this reading. After reading, close V-2.

j. Continue to pump until the desired level is indicated on the portable gauge (15 microns, warm; 1 micron cold).

k. When the annulus is evacuated to the desired level, close V-1. Turn off the vacuum pump and open the vacuum hose bleed valve so it can stabilize.

l. Open V-2 and determine the vacuum level using the portable gauge connected to the vacuum sensor. Record the vacuum level with the annular space. Monitor the indicator for two (2) hours. Watch for any rise in pressure which would indicate a leak.

m. Disconnect the vacuum hose from the flange and inspect for any evidence of pump lubricant which may have been drawn into the area by the vacuum. If no contamination is present, reassemble the gasket and protective cap. If there is evidence of contamination, clean the affected area with freon (See Table 2-1) and test for vacuum loss (Refer to Section VI). Vacuum loss will be immediate if oil has been ingested and the Tank will be unserviceable.

CAUTION

To avoid loss, make sure that the vacuum gauge valve is closed tightly.

n. When the vacuum level has stabilized and is within the appropriate limits, close V-22 (See Figure 1-2). Set the portable vacuum gauge switch to off. Disconnect the vacuum gauge from the vacuum sensor.

5-10. PAINTING AND MARKING.

5-10.1. Repair any damage to painted surfaces in accordance with T.O. 35-1-3, MIL-STD-808 (Refer to Table 1-2), and SA/ALC Drawing 7547352, Requirements for finishes, Protective and Codes for San Antonio ALC Ground and Ground Support Equipment. These are for Type 1 finishes giving protection from climatic elements.

Application shall be made in accordance with the above documents and as follows:

a. Insure that all open ports on the Tank are covered with polyethylene bags or appropriate plugs after the Tank has been drained and purged.

b. Inspect surfaces to be painted with ultra-violet light for evidence of hydrocarbon contamination (hydrocarbons will be fluorescent). If hydrocarbon contaminants are present, then degrease with MIL-C-83873 prepared per manufacturer's instructions. Rinse with water and dry. After cleaning re-inspect.

c. The basic painting materials are:

[1] Epoxy Primer, MIL-P-23377, Type I, Class 2, or Water Borne Epoxy Primer, MIL-P-85582, Type I, Class 2, in yellow.

[2] For Tanks in liquid oxygen service, the paint finish shall be polyurethane in accordance with MIL-C-85285. The color shall be gloss white, No. 17875 as specified in FED-STD-595A.

d. Unpainted Areas. Do not attempt to paint copper line tubing and stainless steel manifolds.

e. Marking. External markings shall be in accordance with MIL-STD-130.

SECTION VI

ASSEMBLY

6-1 GENERAL.

6-1.1 Scope. This section contains assembly instructions for the Skid Mounted Liquid Oxygen/Nitrogen Storage Tank, Type TMU-20/E, 5000 Gallon capacity. Testing instructions are outlined in Section VII, Testing and will be referenced when applicable throughout the text.

6-2 PRECAUTIONS.

6-2.1 Cleanliness. Cleanliness is essential for all components in contact with the product. Spontaneous combustion may occur if the product contacts incompatible cleaning residues or hydrocarbon substances.

a. Environmental Concerns. The Tank should be assembled in unapproved clean area. Parts, tools, and the general environment shall be maintained with a high degree of cleanliness at all times. Any component which contacts the product shall be assembled in a controlled environment and the utmost care shall be taken to prevent contamination of the components.

b. Protection of Components. All bagged and plugged components shall remain so until ready for assembly. Assembled components shall be sealed or bagged until ready for assembly. Components which become contaminated during calibration or component testing, shall be recleaned before installation on the Tank.

6-2.2 Prevention of Damage. Exercise care at all times during Tank assembly to avoid damage or distortion of component. Only tools most suited for a particular application may be used. A suitable fixture, vise, or other type support shall be used to support all applicable components during assembly.

6-3 GENERAL INSTRUCTIONS.

a. Identification Tags. All temporary identification tags shall be removed during installation of the components.

b. Assembly of Threaded Joints and Fittings. Thread sealant (anti-seize) tape conforming to Specification MIL-T-27730 shall be applied to the male threads of all pipe threaded fittings before assembly (See Table 2-2). The exception is for threaded fittings for the vacuum indicator and small tubing connections. These instances will be noted as appropriate in the text. The tape shall be applied starting with the third thread from the end of the fitting. This prevents releasing tape particles into the system. Tape will also be wrapped in the direction of the threads.

c. Lubrication. No lubrication shall be applied to components during installation. The exception will be a small amount of oxygen compatible stopcock grease, KEL-F-90, may be applied to the threads of the stainless steel flange bolts to prevent galling (Refer to Table 2-2).

6-4 ASSEMBLY PROCEDURES.

6-4.1 Order of Assembly. The order of assembly for components on the Tank is generally in the reverse order of disassembly. Instructions are first given for complete assembly followed by component replacement assembly. The steps for component replacement, references steps in the complete assembly. Reference to illustrations are figures in Section III in this manual. Torque values for threaded components can be found in Table 8-1, Table of Limits, Section VIII.

6-4.1.1 Safety Head Assembly. (See Figure 3-1).

a. Safety Head Assembly.

[1] Re-attach spring (4) to spring retainer (5).

[2] Open cap.

[3] Replace spring retainer (5) and spring (4) inside tube (3).

[4] Replace O-ring (2).

[5] Lower relief flange (1).

[6] Cap opening immediately.

6-4.1.2 Manway. (See Figure 3-2).

a. Manway.

[1] Uncover and unseal manway opening.

[2] Replace gasket (2).

[3] Remove cover assembly (1) from LOX clean storage bag. and place into position.

[4] Secure cover assembly (1) with 24, 1/2-inch-20 NF nuts.

6-4.1.3 Front Cabinet. (See Figure 3-3).

a. Front Cabinet.

[1] Remove the vent extension on the vent spool assembly.

[2] Remove cabinet from storage.

[3] Apply Loctite sealant, MIL-S-22437B, Grade A, to Tank where cabinet is to be relocated.

[4] Secure cabinet onto Tank using bolts, nuts, and screws that were removed during disassembly.

[5] Replace the vent extension on the vent spool assembly.

6-4.1.4 Panel Assembly. (See Figure 3-4).

a. Panel Assembly.

[1] Secure panel (1) into place with screws taken from assembly.

[2] Remove cappings or sealings.

[3] Spring tubes back into position.

[4] Connect Swagelok connectors (9 and 10) to panel assembly.

6-4.1.5 Servicing Hose Assembly. (See Figure 3-6).

a. Servicing Hose.

[1] Remove nipple (2) thread protection and replace nipple into metal hose (3).

[2] Insert cone (6) into nut (7) and secure into place using retaining ring (8).

[3] Screw plug (4) into nut (7).

[4] Replace chain assembly (5) onto plug (4) using S-hook. Pinch S-hook into place with a pliers.

[5] Using a spanner wrench, screw female half coupling assembly (1) onto nipple (2).

[6] Replace servicing hose onto storage tube.

6-4.1.6 Coupling Assembly. (See Figure 3-7).

a. Coupling Assembly.

[1] Using a spanner wrench, secure gasket (3) into cap (1) with seat (4).

[2] Replace chain assembly (2) onto cap (1) using S-hook. Pinch S-hook into place using a pliers.

6-4.1.7 Globe Valves. (See Figure 3-10).

a. Globe Valves.

[1] Replace disc insert (14) onto disc plate (15) and secure onto bottom of stem (3) with disc nut (16).

[2] Insert stem (3) inside extension tube (8). Secure this assembly onto the body (18) by screwing on the bonnet ring (10) or the nuts (20) onto the studs (19) on the larger valves.

[3] Replace packing (6) and packing gland (5) into packing nut (4). Replace packing assembly onto stem (3).

[4] Secure packing assembly into place by placing handwheel (2) on top and screwing on wheel nut (1).

6-4.1.8 Pressure Building Coil. (See Figure 3-14).

a. Pressure Building Coil.

[1] By Supporting the pressure building coil laterally, place the coil to side of tank.

[2] Secure coil to side of tank by replacing bolts (1, 5, & 9) and securing them with gaskets (4 & 8), washers (3 & 7) and nuts (2, 6, & 10).

SECTION VII

TESTING

7-1 GENERAL.

7-1.1 Scope. This section contains procedures for testing individual components. Procedures are also given for testing after reassembly and repairs of the Tank have been accomplished.

7-1.2 Precautions. All of the following precautions must be observed by personnel conducting the tests outlined in this section. All personnel operating this Tank must be thoroughly familiar with the hazards associated with the handling of cryogenic equipment and its products. The following is offered as a review.

a. Personnel will wear protective clothing as directed in T.O. 00-25-172.

b. Do not allow any bodily contact with the liquid product or the extremely cold Tank piping. Following established procedures in the event of accidental contact. Know what to do.

c. Keep the Tank and surrounding area, tools, equipment, and clothing completely free of hydrocarbons.

d. Testing must be accomplished in a well ventilated area. Avoid a concentration of gases from spills and venting.

e. Do not smoke or permit smoking within fifty (50) feet of Tanks in oxygen service. Don't carry sources of flame in the vicinity of Tanks in oxygen service.

f. Keep both liquid and gaseous oxygen away from absorbent materials, loose clothing and rags. These materials can trap oxygen which can later be ignited by any source of spark or flame.

g. Do not allow liquid or gaseous oxygen to vent into areas containing grease, oil, gasoline, kerosene, aviation fuel, or any other hydrocarbons. These substances are not compatible with LOX and if brought into contact spontaneous combustion may result.

h. Never confine the liquid product in any piping container (e.g. thermos bottle) without proper pressure relief devices. These containers will explode due to the product building extremely high pressures.

7-1.3 Equipment Operational Safety. The Tank presents several hazards which must be considered by operating personnel. The equipment and product is not necessarily dangerous. Failure to observe normal precautions can lead to serious injury to personnel and damage to equipment.

a. Static Grounding. Prior to use, the Tank shall be grounded against the effects of static electricity (Refer to Figure 3-1, Operation and Maintenance Instructions, T.O. 37C2-8-19-11).

b. Relief and Vent Valves. Personnel must be constantly aware that vapor or liquid product may be vented from the Tank at any time. The fill/drain line pressure relief valve (RV-2) is shown in Figure 3-4. The servicing line pressure relief valve (RV-1) is shown in Figure 3-3.

The vapor vent line directs gas discharge down and away from the control housing and is shown in Figure 3-6. It must be clear of all obstructions such as plugs, tape, polyethylene bags, and external blockages.

c. Control Valves. The manual control valves are installed in their respective manifolds and are exposed when the front door of the control housing are opened. They should be operated in the manner indicated in T.O. 37C2-8-19-11, Operation and Maintenance Instructions.

7-2 MEASUREMENTS AND INSTRUMENTATION.

7-2.1 Accuracy of Measurements. All equipment used in testing shall be of laboratory precision as far as practicable. The equipment shall be calibrated at intervals properly sequenced to continue laboratory accuracy.

a. Indicator Pressures. Data on indicator pressures measured in the range from 0 to 100 psig shall be accurate to within two (2) percent of full scale.

b. Weigh Measurements. Data on product measurements obtained by scale weights of the Tank and the product shall be accurate to within five (5) percent.

c. Gas Flow Rates. Data on gas flow rates shall be accurate to within three (3) percent.

7-2.2 Instrumentation. Tank use requires reading pressures in relation to liquid level and vapor pressure. These indicators are located on the control panel (See Figure 3-4).

a. Tank Pressures. Tank pressures are measured by the vapor phase pressure indicator (PI-1). Tank pressures above atmospheric pressure shall be measured by PI-1.

b. Tank Liquid Levels. Tank liquid levels are measured by the Tank liquid level indicator (LL-1). Tank liquid levels shall be measured by LL-1. The liquid level can be determined by weighing the Tank. Weighing should be measured by scales designed for this particular type of measurement and shall be recorded in pounds. The pound weight may additionally be converted into gallons.

NOTE

LL-1 will not present an accurate indication during filling, draining or pressure buildup operations due to pressure surges. Allow the product to stabilize before recording indicator readings from LL-1.

7-3 TESTING PROCEDURES.

7-3.1 Cleanliness Testing. Refer to Section V, Paragraph 5-5.3 for inspection of the interior and exterior of the Tank.

7-3.2 Leak Detection. Leakage, internal and external, is most often detected by visual observation. Frosted piping indicates that product is escaping through a valve. Cold spots on the Tank's outer shell indicated a possible vacuum leak. Frosted valve stems indicates a worn packing or packing nut which needs tightening. These symptoms and suggested remedied are listed in Table 5-1, Operation and Maintenance Instructions, T.O. 37C2-8-19-11. Small leaks such as losses of 10 to 50

microns of vacuum per day cannot be detected or repaired by ordinary methods.

a. Vacuum Leak Detection. Vacuum leak detection requires contractor or depot facilities, trained and experienced personnel, and the employment of helium mass spectrometer equipment. The following information is only to verify if an inner shell leak does actually exist:

[1] Leakage of the inner shell into the annular space will generally be indicated by the outer shell safety head (SD-1) located on the rear of the Tank. If it is pushed out then internal leakage is probable. This type of leak cannot be field repaired.

[2] The method of determining the level of vacuum in the annular space is outlined in Section V of the Operation and Maintenance Instructions, T.O. 37C2-8-19-11.

NOTE

Report leaking to the proper authorities. Do not attempt makeshift repairs.

b. Pressure Leak Detection. Pressure leak detection consists primarily of pressurizing the piping systems and making a bubble test with Leak Detection Compound MIL-C-25567C (Refer to Table 2-2). DO NOT USE OTHER LEAK DETECTION COMPOUNDS WHICH MAY NOT BE OXYGEN COMPATIBLE (Refer to Figure 1-3).

[1] Obtain a source of clean, dry nitrogen gas (Specification BB-N-411, See Table 2-2) of at least 50 psig.

[2] Using an appropriate hose and fittings attach the nitrogen source to the servicing line coupling. If the service hose is attached, disconnect it from the servicing line coupling and wrap the end with a polyethylene bag and seal it.

[3] Make sure the servicing line shutoff valve (V-5) and the servicing line drain valve (V-6) are closed.

[4] Open the nitrogen source valve and pressurize the servicing line.

[5] Follow the instructions package with the leak detector compound and apply the compound to each threaded connection in the line.

[6] Tighten connections to stop leaks. If tightening fails to stop leakage, then disassemble and determine the cause of the problem. Make appropriate repairs as necessary.

[7] Upon completion of the leak test, close the nitrogen source valve and open V-4 to drain off the pressure in the hose.

[8] Disconnect the nitrogen source hose and reconnect the service hose.

[9] Attach the nitrogen source hose to the fill/drain coupling.

[10] Make sure the fill/drain line shutoff valve (V-5) and the fill drain line drain valve (V-6) are closed.

[11] Open the nitrogen source valve and pressurize the fill/drain line.

[12] Repeat previous steps 5 and 6.

[13] Upon completion of the leak test of the fill/drain line, regulate the nitrogen source to 50 psig.

[14] Make sure vapor vent line shutoff valve (V-10) and the full trycock valve (V-2) are closed.

[15] Open V-7 and fill the Tank with nitrogen to 50 psig.

[16] Repeat previous steps 5 and 6 for vapor vent manifold, control panel, pressure buildup coil, and V-9.

[17] After all leak checks and repairs have been made, pressurize the Tank to 50 psig and allow it to stabilize for 24 hours at constant temperature. Check indicators for pressure loss. If the pressure loss is excessive then re-check for leaks.

NOTE

Temperature changes can cause slight variations in Tank pressure and must be considered.

7-3.3 Evaporation Loss Testing. These tests determine the adequacy of the insulation and vacuum in the annular space. This is accomplished by measuring the evaporation loss rate at ambient temperature and pressure. Two (2) methods are offered: one (1) is to use the Dual Efficiency Meter and, two (2) is to measure the volume of evaporated product.

a. Dual Efficiency Meter Method. Refer to T.O. 37C2-8-27-11.

b. Volume Weight. A suitable totalizing flowmeter (See Table 2-1) is required. This flowmeter is usually available from the PMEL or Fuels Laboratory.

[1] Fill the Tank to 50% capacity (2500 gallons) and allow the liquid to stabilize for 12 to 24 hours.

[2] Open the vapor vent line shutoff valve (V-10) and lower the Tank pressure to atmospheric zero (0) on the vapor phase pressure indicator (PI-1).

[3] Attach the flowmeter to the vapor vent line discharge end and set the flowmeter to zero (0).

[4] Leaving V-10 in the open position, allow all of the vapor vented from the inner shell to pass through the flowmeter for a period of 24 hours.

NOTE

The inner shell pressure will remain at or near atmospheric as the necessary pressure dropping through the flowmeter will allow.

[5] Record the volume of vapors which have flowed through the meter and calculate (cubic feet of vapors X 13.66 at 70°F) the

weight of the evaporated product. It must not exceed 19 pounds.

(6) Disconnect the flowmeter and return V-10 to its normal position for idle storage.

7-3.4 Vacuum Retention Testing. This test is related to both the leak testing and evaporation loss testing. The following procedures are a supplementary verification of those test results.

a. Testing Procedure.

(1) Fill the Tank with liquid product and allow it to stabilize for four (4) hours.

(2) Following the procedures outlined in Section V of T.O. 37C2-8-19-11, Operation and Maintenance Instructions, use a vacuum gauge (refer to table 2-1) and determine the vacuum level of the annular space.

(3) Allow the Tank to remain undisturbed for thirty-six (36) hours and repeat the test of paragraph (2). There must not be any pressure increase attributable to leaks.

7-3.5 Relief Valve Testing. The line relief valves may be tested by attaching them to a regulated source of dry nitrogen gas and increasing the pressure until they open to relieve. The Tank pressure relief valve (RV-3) may be tested by increasing the pressure in the Tank using the pressure buildup control valve (V-9) and noting the pressure at which the valve relieves. RV-3 can be removed from the vapor vent manifold and tested in the same manner as the line relief valves.

CAUTION

Do not attempt to adjust any of the relief valves. The Tank pressure relief valve is a sealed, ASME Code certified unit, do not tamper with it. Failed relief valves should be condemned and disposed of through regular channels.

a. Line Relief Valves. Line relief valves (see figure 3-4) should relieve and reset at 75 psig.

b. Tank Pressure Relief Valve. The Tank pressure relief valve (see figure 3-10) should relieve and reset at 55 psig.

SECTION VIII

TABLE OF LIMITS

8-1 GENERAL.

8-1.2 General Information. This section consists of a table of limits (Table 8-1) applicable to equipment items covered by this manual. Maximum and minimum limits, as appropriate, refer only to the limits beyond which the item may not be continued in service.

Table 8-1. Table of Limits.

ITEM	LIMITS
Top vent flange bolt	Torque to 30-35 ft-lb
Union	Torque to 100 ft-lb
Valve seat disc screw	Torque to 24 in-lb
Valve bonnet	Torque to 50 in-lb
Inner tank relief valve	Set at 55 psi
Fill line relief valve	Set at 75 psi
Service line relief valve	Set at 75 psi
Burst disc	Rated at 84 psi

SECTION IX

ILLUSTRATED PARTS BREAKDOWN

9-1 GENERAL.

9-1.1 Scope. Refer to T.O. 37C2-8-19-14, Illustrated Parts Breakdown, for a complete listing of parts and illustrations.

SECTION X

DIFFERENCE DATA SHEET

10-1 GENERAL.

10-1.1 Scope. No difference data sheets have been prepared for this Tank.